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Building Bridge Substructures on the Grand Trunk Pacific Ry.

By W. C. Ruegnitz*

One of the most interesting features of construction on the Pacific Coast section of the new transcontinental line of the Grand Trunk Pacific Ry. is the bridge foundation work along the Fraser River between Tete Jaune Cache and Fort George, in British Columbia. For 185 miles between these points the railway follows the Fraser River through several ranges of mountains, the distance by river being 300 miles. The country is wild and rugged, and inhabited mainly by Indians and trappers.

In the summer the melting glaciers and snow turn the streams into deep, swift rivers, and because of the scour and swift current exceptionally good foundations are required. Temporary bridges could not be maintained over the larger and more dangerous rivers, and it was necessary to complete the substructures in advance of track in order to allow the quick erection of the superstructure when tracklaying reached the various bridge sites.

There are ten permanent bridges, from 2658 ft. in length to single-girder spans, and the three longest bridges cross the Fraser River. The substructure work of these bridges was commenced by some small individual contracts, but it was soon evident that it could not be carried on satisfactorily or with the necessary speed. In July, 1912, the contract for all the bridge substructure work from Tete Jaune Cache westward for some 450 miles or to within about 200 miles of Prince Rupert (the Pacific terminal) was awarded to the Bates & Rogers Construction Co., of Chicago. The writer was superintendent of construction for this company on the division between Tete Jaune Cache and Fort George, and work on this division was completed in May, 1914.

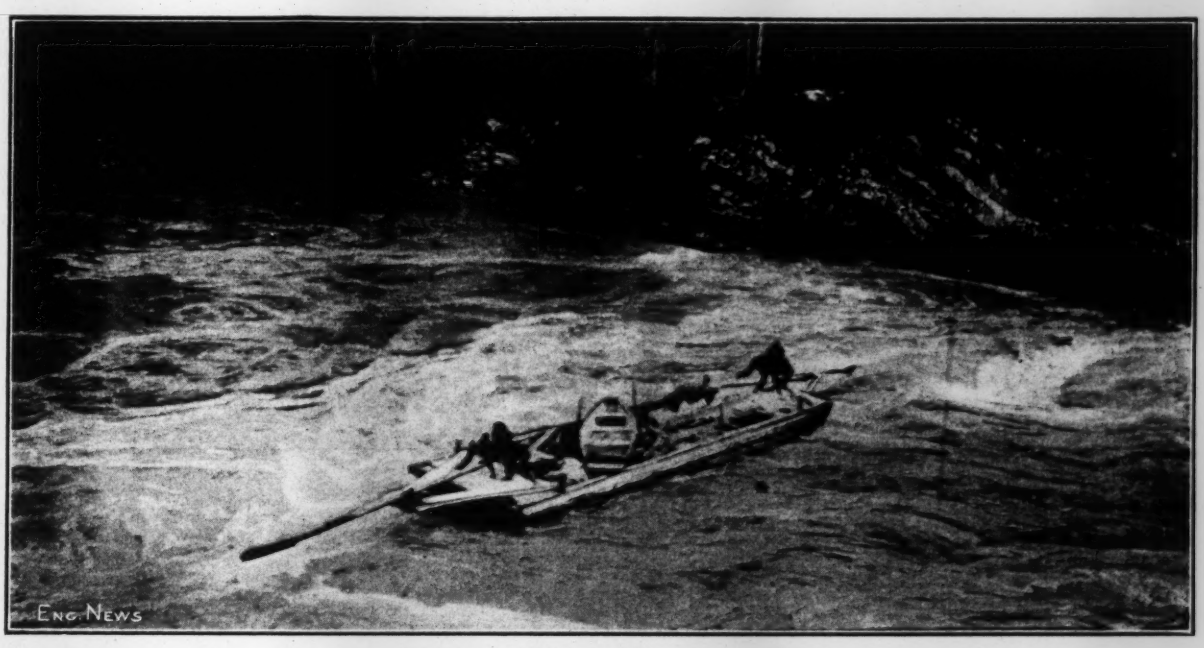

Fig. 1. Taking Construction Material and Supplies Down the Fraser River on Scows

Supplies and Camps

To complete the difficult foundations in the short time allotted and under the conditions described, necessitated very careful preparation. Markets for labor, plant and material were far away. Men were often shipped from Montreal and Boston, a trip of 10 to 14 days. Cement and steel from eastern Canada and Pennsylvania, requiring a lake and rail shipment, were often weeks in getting to destination. The base of supplies was at Tete Jaune Cache, at the end of the track. Here it was necessary to assemble all requirements to be freighted to the bridge sites.

The nature of the country was such that wagon roads were impossible, and the only means of delivering material was by boat or scow on the Fraser River, which is navigable only during the high-water period. Actual construction had to be carried on during the low-water period, which begins usually in October or November and

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continues until April or May. Thus the high-water period was a time of preparation. Camps had to be established quickly, and plant, supplies and material had to be assembled and stored at the various sites. The smallest details had to be carefully worked out in advance, as each camp would be without freight communication during much of the construction period.

single-line telephone system serving all the camps provided a wonderful help, although the line was not as good as the ordinary party line of the rural settlements. Most of the camps were located in heavily wooded districts, and fuel for all uses was cut during the summer months. Foundation piling and round timbers for construction purposes were cut in the fall and delivered to the sites

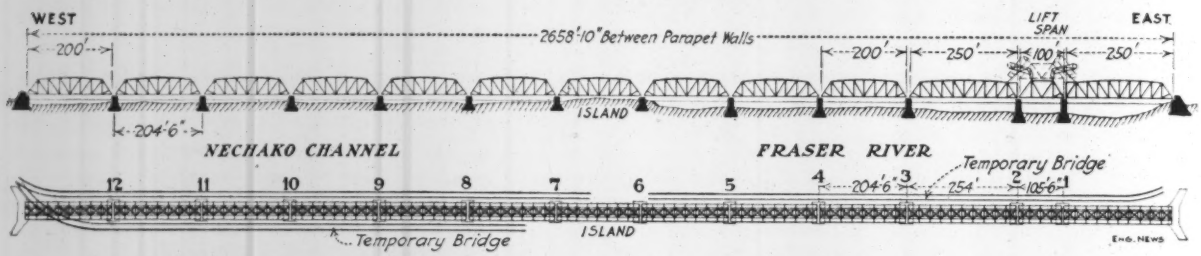

FIG. 2. BRIDGE AT THE FOURTH CROSSING OF THE FRASER RIVER; GRAND TRUNK PACIFIC RY.

Stern-wheel steamers of the usual river type were built to handle the freight but they could not begin to deliver all the enormous tonnage. Hence hundreds of scows 36 to 40 ft. long, 12 to 14 ft. wide, and carrying 12 to 25 tons each were floated to the jobs. They were handled by sweeps at both ends, each sweep being manned by two men. In the more dangerous cañons and rapids, pilots and extra men were put on to assist the regular crews, but even with this precaution entire cargoes were frequently lost. The average mileage per day for a scow was 50 miles, while one would frequently make 70 miles. Their progress was augmented by the swift currents and the long summer days of the North. Fig. 1 shows the character of this transportation.

Nearly all cement was delivered by scows that were from 5 to 14 days on the way. False bottoms, covered with straw to absorb the moisture, served as a floor to receive the cement. The sides and ends of the cargo were also protected by straw, while the top was covered with a heavy oiled canvas. Run boards were provided to protect the cargo from the boot calks worn by the rivermen. From the time the cement left the mill until stored on the job it was handled eight times.

The camps presented exceptional requirements. Ample storage room was necessary to acommodate the material and supplies that had to be delivered in advance of construction. Preparation for the long cold winter had to be made, and bunkhouses of logs well banked were used when lumber could not be easily procured. Sanitary conditions had to meet the requirements of the British Columbia Government. During the fall, when it was impossible to deliver fresh meat from the base of supplies, cattle were driven to the camps or trappers furnished the contractors with caribou or moose meat.

When navigation was closed, the only means of getting to camps was by walking. Mail and small supplies were packed in. During the colder months, dog teams were used, and teams and sleds when the ice permitted. A by water before ice closed the river. Square timbers were hewed on the job, there being many expert broad-axe men available.

SUBSTRUCTURE OF THE FRASER RIVER BRIDGE

All the bridges presented special difficulties but the largest and most interesting is that at Fourth Crossing, one mile east of the old Hudson's Bay Co. Post known as Fort George. It is just below the confluence of the Fraser and Nechaco Rivers. Here the line crosses an island, with the deep-water channel, known as the Fraser, on the east side, while the Nechaco, an overflow channel during high water, is on the west side. The length of the bridge is 2658 ft. As shown in Fig. 2, there are ten spans of 200 ft. and two of 250 ft., one at either end of the 100-ft. lift span. The truss-seat elevation at pier No. 1 is 1867 above sea level, and the elevation of the river bed

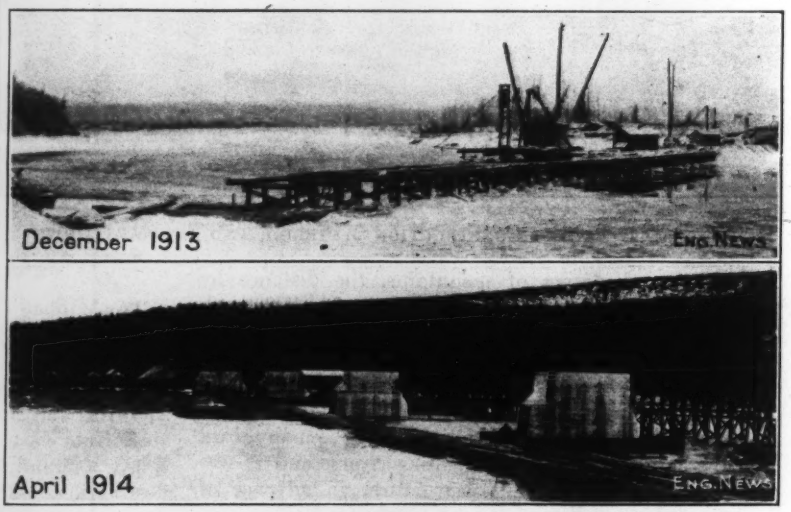

FIG. 3. STAGES OF WORK ON THE PIERS FOR THE FOURTH CROSSING BRIDGE, FRASER RIVER

is 1823. High-water level is assumed as 1858 and the low water as 1839.

The ideal location of the island was utilized by the contractors for their camp, accommodating 600 men. This was laid out in streets. The bunkhouses were frame

buildings covered with prepared roofing. The storehouses for cement and material were large frame buildings covered with heavy oiled tarpaulins or "tarps," an exceptionally fine canvas made in Scotland. Tarps that had protected the cement on the river trip were used to cover the buildings. An auxiliary camp to accommodate 100 men was established on the east bank, on account of the great danger in taking laborers across the main channel during the ice floes before the contractors temporary bridge was completed. This proved very fortunate, for in the spring, when the ice took out all temporary structures, the work on the east bank was carried on without interruption.

A complete day and night organization was maintained for the entire work, each pier having a complete plant layout as well as an individual crew. A night and day foreman for each pier worked together, shifting their crews every two weeks. Each foreman reported to the general foreman, there being one general foreman for each shift. The general foremen reported to the superintendent in charge, who was located on the work. Fig. 3 shows the condition of work in December, 1913, and April, 1914.

Construction Work

The substructure consists of 12 concrete piers and two abutments, all resting on pile foundations, as shown. The deepest foundations are at piers Nos. 1 and 2, which were carried 25 ft. below low water, requiring 10-ft. steel sheeting. An ice jam which raised the water several feet above the top of the sheeting delayed all operations for several days. Careful soundings were taken before the work was started and showed a gravel bed with an underlying strata of very stiff sandy clay with layers of quicksand. The depth of gravel varied at different pier sites.

An exhaustive study of the individual pier and abutment sites was made by the contractors, and coffer-dams were designed both as to kind and strength to suit the local conditions. Three types of coffer-dams were used; crib, steel sheeting and a single row of Wakefield wood sheeting. The size of coffer-dams was designed to allow ample room for the necessary coffer-dam piles, bracing and timbers. The braces were spaced in order to allow of dredging with grab buckets and to permit the placing of pumping equipment.

Actual work on the shore was commenced in September, 1913, on the east abutment and pier No. 6, the only units then accessible. The temporary bridge from which all work was directed was started at this time and carried out as far as navigation laws permitted. Later, when floating ice stopped navigation, it was found a very difficult task to drive the remainder of the bridge and it was not until January that it was entirely completed. The river, with a current of 4½ to 5 m.p.h. and filled with ice, presented a formidable obstacle not only against the temporary bridge but it seriously hindered the placing of the coffer-dams.

The general program of construction for each pier was as follows:

1. Open dredging was carried down as far as possible.
2. The coffer-dams were then built. The crib coffer-dams were built and sunk in the ordinary way. For the steel coffer-dams, wood piles spaced about 8 ft. c. to c. were driven around the space to be inclosed; these were carefully lined up and two sets of timbers 4 ft. apart bolted on the inside piles (above the water) to act as guides for the steel sheeting. In Fig. 4 is shown a complete set of the steel sheeting in place and ready to be driven. Three or four complete sets of waling and bracing were then sunk into position and set as deep as possible. The steel sheeting was then set inside the guide timbers and around the waling, care being taken to get a locked dam. After closure the steel was driven the full depth required, usually 6 ft. below the elevation required for the bottom of the foundation.
3. Excavation inside the coffer-dam was continued with dredges (Fig. 5), teeth being used on clam-shell buckets when clay was encountered. The waling and bracing was sunk as the excavation proceeded. The excavation was usually carried 1 to 2 ft. below the bottom elevation required, in order to allow for swell caused by driving the foundation piles.
4. When excavation was completed, the foundation piles were driven and cut off under water at the elevation required by means of a saw (Fig. 5). The penetration of this piling usually averaged over 20 ft. below cutoff. The driving was very hard.
5. Concrete was then placed under water by means of bottom-dump buckets, using a 1:2:4 mixture. The amount of sealing used was carefully figured to prevent floating or "blow-in." The sealing was allowed to set from two to six days, depending upon the depth of water and temperature.
6. When the concrete was properly set the coffer-dam was pumped out. As the water was lowered, the bracing was examined and strengthened or repaired if necessary.

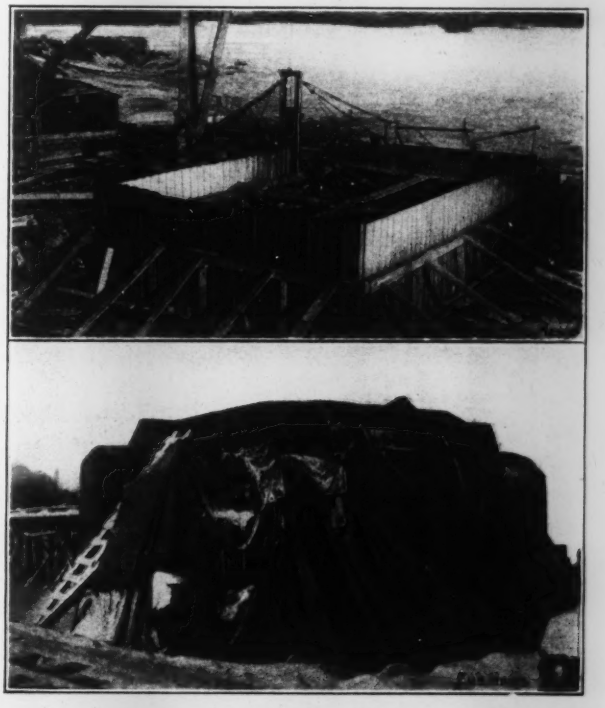

Fig. 4. Substructure Work on the Fourth Crossing Bridge

(Top view, steel sheeting for coffer-dam erected in place and ready to be driven. Bottom view, completed form and concrete pier incased with canvas, inside of which are steam pipes. (Temperature, 50° below zero.)

EXAMPLE OF CONTRACTOR'S WEEKLY PROGRESS REPORT ON BRIDGE SUBSTRUCTURE WORK
FRASER RIVER BRIDGE

Unit	Dry excavation Total quan.	Dry excavation Total to date	Dry excavation Amt. this week	Net excavation Total quan.	Net excavation Total to date	Net excavation Amt. this week	Foundation piles Total quan.	Foundation piles Total to date	Foundation piles Amt. this week	Concrete Total quan.	Concrete Total to date	Concrete Amt. this week	Cofferdam	Remarks
E. abut.	1776	1776	....	2,778	2,778	....	386	386	....	2692	2437	413	Steel sh't'g. to be pulled—both wings	S. Wing, building forms and concreting.
Pier 1	....	....	....	1,853	1,853	....	210	210	....	1260	1260	....	112 pcs. sheeting to pull	Clearing driftwood and removing waling.
Pier 2	....	....	....	1,808	1,808	....	193	193	....	1100	1100	....	96 pcs. sheeting to pull	Preparing to cut off channel sheeting.
Pier 3	....	....	....	1,078	1,078	....	208	208	....	948	948	....	120 pcs. sheeting to pull	Pulling steel sheeting.
Pier 4	....	....	....	1,428	1,428	....	170	170	....	1116	1116	....	....	....
Pier 5	....	....	....	992	992	....	170	170	....	834	834	....	142 pcs. sheeting to pull	....
Pier 6	187	187	....	1,285	1,285	....	170	170	....	984	984	....	Sheeting pulled	....
Total	1963	1963	....	11,222	11,222	....	1507	1507	....	8934	8979	413		Date:—

The results in all cases showed exceptionally good masonry.

7. Forms were built (Fig. 5) and the pier concreted, using 1:3:5 mixture, the necessary precautions being taken (as described below) to protect it against severe weather.

Concrete Work

For the Fraser Channel, two concrete plants were used, one on the island and one on the east bank. Gravel was taken from the river and stored in a network of hollow boxes into which steam was turned, thus keeping the gravel hot even during weather 50° below zero. Cement which had been delivered by scow was stored at both mixer plants. The concrete was taken from the mixer to the piers in buckets on cars handled by an endless cable. It was delivered so quickly that it was not affected by the cold before being put into the forms.

On the Nechaco Channel, enough gravel was obtained from the excavation of each pier, and a mixer was set up at each pier; the only material to be hauled being cement.

To prevent freezing, the gravel was heated as mentioned above. Water was also heated, the mixed concrete coming to the forms very warm. The forms were entirely covered by heavy oiled canvas tarps, these extending from the top of the coffer-dams to the top of the forms, completely inclosing the pier, as shown in Fig. 4. Between the forms and canvas covering, fires were kept in small stoves, or steam heat was furnished in radiators built on the work. Both methods are good but steam was preferred and used where there was an available supply on account of danger of fire from the stoves.

Steam was always turned in at the top of pier when completed. Heating was continued for 3 to 7 days after masonry was placed and the forms were stripped in from 7 to 10 days. The results obtained were remarkable. The masonry is smooth and of a uniform color and there are no indications that frost penetrated anywhere.

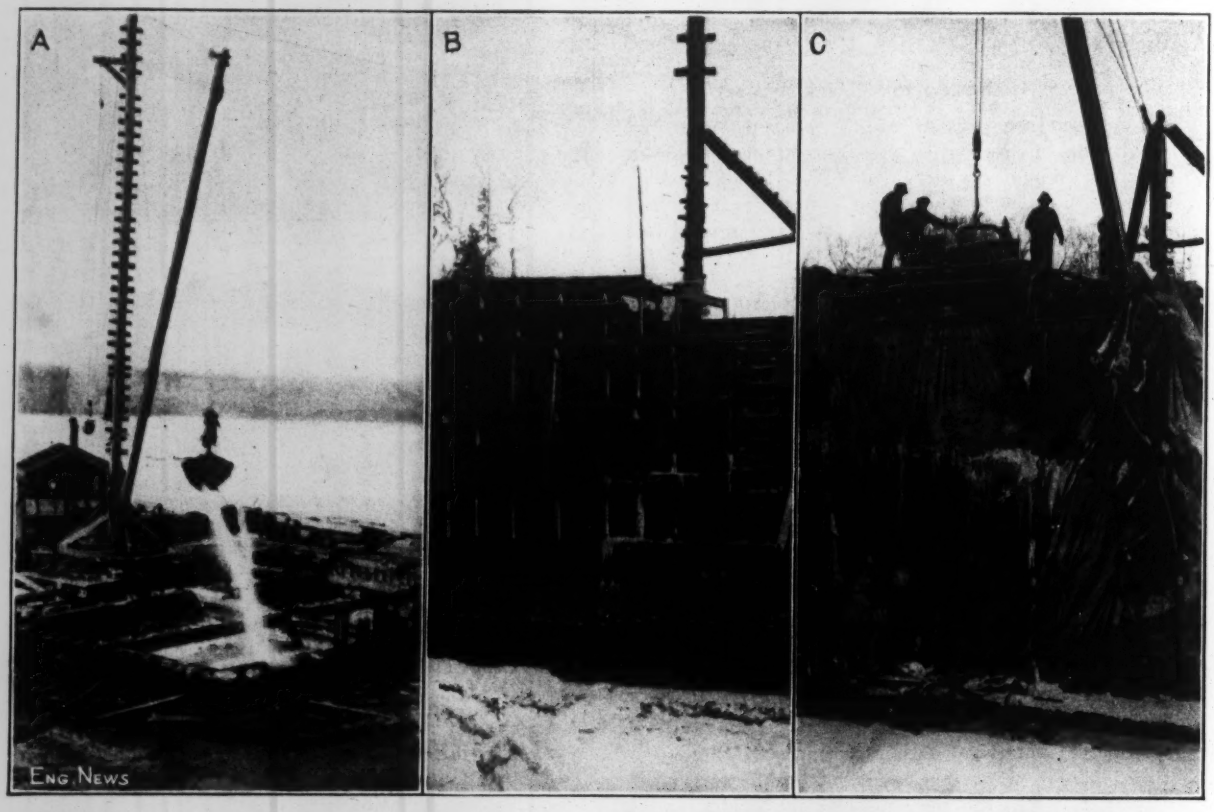

Fig. 5. Work on the Piers of the Fourth Crossing Bridge, Fraser River; Grand Trunk Pacific Ry.
(A. Dredging inside steel coffer-dam and commencement of bracing. B. Completed form for pier, showing steel sheeting of coffer-dam. C. Pouring concrete into a form covered with canvas.)

The forms had to be well built and braced with more than ordinary care before placing concrete, because the canvas covering did not leave an opportunity to examine the forms to determine if they were being kept in line.

Progress Records

The weekly progress report used by the contractor was a white print 28 in. long showing an elevation and plan of the bridge (on which the concrete progress was marked) and a profile of the river bed on which the progress of coffer-dams and pile foundations was marked. On the print was a table for the excavation, coffer-dam, piling and concrete at each pier, the table being filled in each week. The accompanying table gives one of these weekly reports of work of the main channel of the Fraser River for the Fourth Crossing bridge, shown in Fig. 2. In addition to this, a monthly report was made for each pier or abutment, showing the progress, materials used, etc., and the condition of the work. These graphic reports were made up at the superintendent's office and forwarded to the main office of the contractors, in Chicago.

Concrete Retaining-Wall for Flood Protection at Schenectady

A low concrete retaining-wall more than a mile in length was completed Sept. 1 by the General Electric Co., at Schenectady, N. Y., to protect its works from freshets in the Mohawk River. The property of the company is located a few hundred feet south of this winding river and adjacent bottom lands. Between the river road upon which the plant buildings front and the river channels, is the Erie Canal.

Previous to the spring of 1914, the banks of the canal prevented overflow into the works. The towpath of the canal is 6 ft. higher than the floor level of the works and permits a rise of 23 ft. of the Mohawk River before water can overflow the top of the canal and flood the plant.

This stage was exceeded in March, 1914, when the towpath of the Erie Canal was overflowed, closing navigation. Fortunately, at this juncture the ice gorges in the river broke, preventing a general inundation of the works. Water overflowed many of the principal streets in the lower sections of Schenectady, to a depth of 2 to 5 ft. The normal flow of the river in this vicinity is from 5000 to 7000 cu.ft. per sec.; but in the spring of 1913, reached 105,000 to 110,000 sec.-ft.

Utilizing the Mohawk River for the Barge Canal made it necessary to create a pool 11 miles long with a dam 30 ft. high at Visschers Ferry, 3 mi. below Schenectady. This raised the general water level about 2 ft., which accounts largely for the high stage this year. Engineers of the General Electric Co., last January investigated the situation and recommended raising the present heelpath masonry walls of the Erie Canal about 3 ft. and increasing the height of the old dike extending around the southwest end of the company's property.

Work started on July 13 and was completed in six weeks by a gang of 25 men. The new flood-protection wall extends west from the Washington Ave. bridge to the earth dike. It is 5100 ft. long and about 2 ft. 6 in. high. It is 24 in. thick at the base and 14 in. at the top. It is dovetailed to the rubble-concrete canal wall. Thirty tie-rods of 1¼-in. steel 24 ft. long embedded in concrete and anchored to concrete deadmen, backbrace the heelpath wall to the embankment, where the old wall was out of plumb. Blaw steel forms were employed and all material was transported and mixed on scows. The wall contains more than 1000 cu.yd. of concrete.

A short section of the wall 225 ft. long will be run on the heelpath of the canal, starting just east of the Washington Ave. bridge and extending to a point where it can be directed across along the side of the illuminating laboratory, onto and abutting the New York Central railway embankment.

The work was done under the direction of Carl G. Hulth, Engineer and Superintendent of Grounds and Buildings for the company, and Chas. H. Benedict, Assistant Superintendent for the Eastern Division of the State Department of Public Works.

*Information furnished by General Electric Co.

A Highway Crossing Signal now in use on the Lehigh Valley R.R. and other lines comprises a disk, lamp and gong in its indications. The signal is of the banjo type, with circular box mounted on a post as in an old form of automatic block signal. The signal is held at the "clear" position by magnetic attraction, but when the control circuit is broken by the approach of a train the magnet coils are demagnetized and the mechanism goes to the "stop" position by gravity, showing a large red disk at the larger opening in the box and bringing a red glass opposite the lamp opening. The gong is housed at the lower end of the banjo box. One design of the signal shows indications in both directions, so that only one signal is required for the crossing. This crossing signal is a development of the old Hall automatic block type.

Low Concrete Retaining Wall on Heelpath of Erie Canal

Experimental Levees with Concrete Paving and Sheet-Pile Cutoff, Mississippi River

By C. O. Sherrill*

The years 1912 and 1913 were characterized by the greatest floods ever known on the Mississippi River, and efforts of the United States Government and the local authorities to hold these floods between the levees are well known to all. These efforts, in effect, were directed against 2,200,000 cu.ft. per sec. of water flowing down the river between levees constructed to grade for 1,750,000

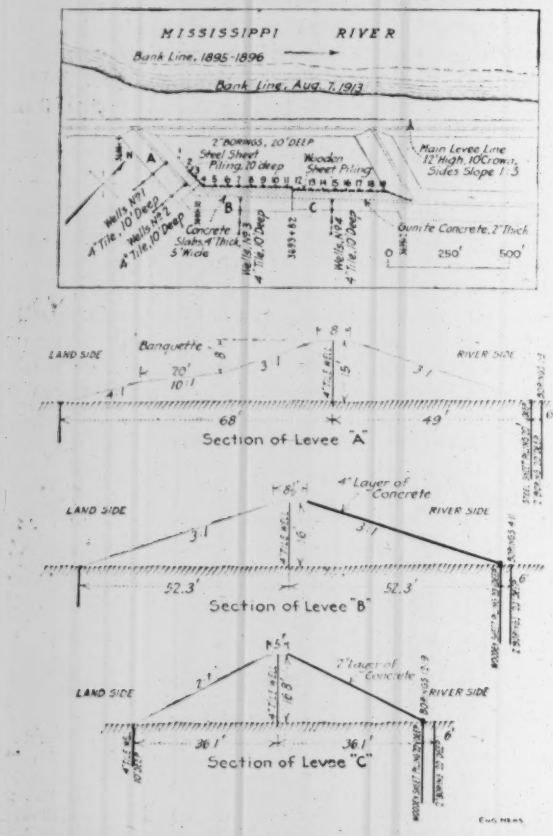

Fig. 1. Experimental Levee with Face Protection and Pile Cutoff at Upper Fairfield, Mississippi River

cu.ft. per sec. As a result, all the levees were strained to the utmost and every known variety of defect developed and had to be combated.

It was found that in certain classes of soil excessive seepage and sand boils occurred, even in the then standard levees. To determine the effectiveness of various forms of protection, the Fourth District, Mississippi River Commission, undertook certain experimental work, described below, with a view to determining whether a smaller section levee protected with gunite (concrete deposited by the cement gun) over its face and with interlocking sheet piling extending 8 to 10 ft. deep at the foot of the levee would not decrease the percolation of water through the levee so as to keep it dry for the average period of highest flood; namely, 30 to 40 days.

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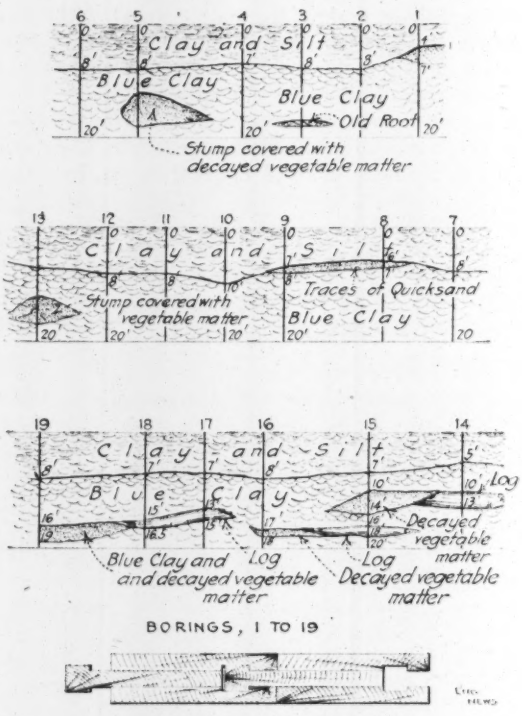
The writer undertook these experiments with the idea that the protection of levees in this way would add largely to the friction of the water flowing through the levee, due to the necessity of its passing over the longer path around the bottom of the sheet piling and upward toward the surface against gravity and frictional resistance of the soil; and that for the period during which levees are subjected to the pressure of flood water this increased resistance to percolation would probably delay the rise of the seepage planes sufficiently to allow the levee to remain dry until the danger was passed. It has been thoroughly demonstrated, moreover, that a dry levee of any size practicable to build is a safe levee, and that any

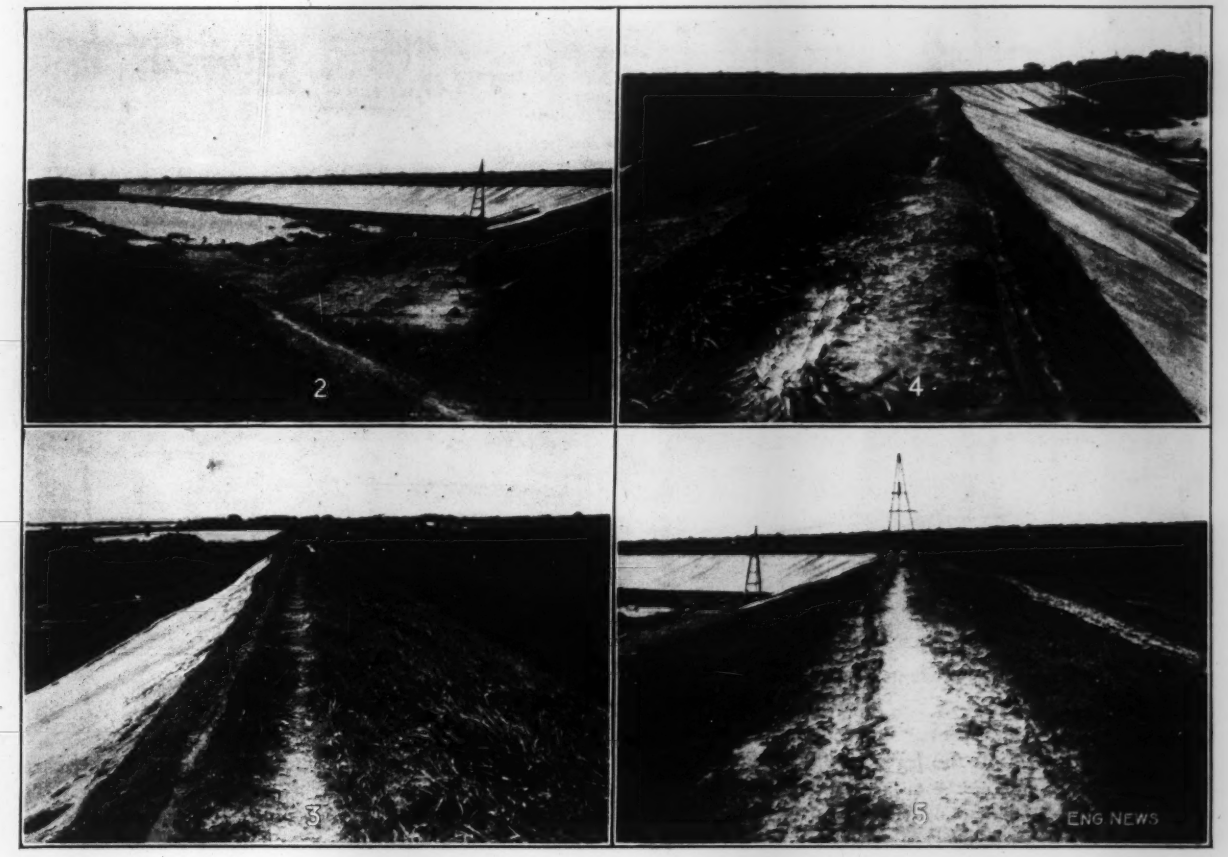


Section of sheet pile

thoroughly saturated levee, no matter how large its section, is useless as a means of protection.

The proposed protection work has been completed and consists of the following: A levee 1276 ft. long, shown in Fig. 1, was built in the rear of the main line to form a basin in which water could be impounded. The upper wing (*A* in Fig. 1) is full standard section with banquette and no additional protection; a length of 382 ft. (*B* in Fig. 1) is standard section without banquette, slopes 1 on 3, and has 4-in. concrete slabs for face protection and 20-ft. sheet-pile protection; the remainder (*C* in Fig. 1) has a 5-ft. crown and slopes of 1 on 2, with a 2-in. gunite face protection and 20-ft. wood interlocking sheet piles.

A length of 50 ft. in *A* has a concrete and interlocking steel-pile protection, placed at the expense of the Lackawanna Steel Company to test their new 11-lb. steel interlocking piling. Except for this 50 ft. of steel piling, the remainder, 857 lin.ft., was of interlocking heart pine type 5½ in. thick, driven 20 ft. deep. This piling proved easy to drive, as there was no tendency for the piles to drift, either at top or bottom, due to the interlocking.



FIGS. 2-5. VIEWS OF EXPERIMENTAL LEVEE BEFORE FILLING

(Fig. 2. General view of basin. Fig. 3. Small section levee, one on two slopes, 5-ft. crown, 2-in. Gunite face protection, wood sheet piles. ("C" in Fig. 1.) Fig. 4. Levee with one on three slopes, 8-ft. crown, 4-in. concrete slab protection. ("B" in Fig. 1.) Fig. 5. Standard Levee, 8-ft. crown, one on three slopes and 20-ft. banquette. No protection. ("A" in Fig. 1.)

Practically all the piles were driven full 20-ft. penetration with an average of 20 blows per double pile. A drop hammer weighing 2350 lb., with a fall of 12 ft., was used.

There had been previously used by the Fourth District office various types of wood piles for levee protection, including Wakefield, dovetail-interlock, spline and groove, and tongue and groove, but none of these can compare with the standard interlocking type, patented by Alexandria Lumber Co., Alexandria, La., and shown in Fig. 1, as to ease of driving and water-tightness. The steel piling gives a good interlock, but on account of its light section was difficult to drive in the hard soil found at Fairfield; and it costs considerably more than wood. The Lackawanna Steel Co., however, is experimenting further with this piling, and it is believed that with a properly designed steam hammer and driving cap it can be satisfactorily driven in the hard soil at this locality. The writer saw some of it driven with success at the Lackawanna plant in comparatively soft ground. There is some doubt whether it will last for any great length of time unless made of special nonrusting composition.

Upon the surface of the protected portions of the levee was placed either ordinary concrete (1:3:5) 4 in. thick, or gunite, 2 in. thick. The gunite was placed on a levee of small sections, namely: 5-ft. crown, with slopes 1 on 2, to give it as severe a test as possible in comparison with the ordinary concrete. The 4-in. monolithic concrete was placed on a levee having 8-ft. crown and slopes 1 on 3. The largest section levee, which is the standard Mississippi River Commission type, was left unprotected in order to have a direct comparison between this levee's efficiency and that of the smaller protected sections.

Gunite was placed on the levee in several different

FIG. 6. SECTION OF THE INTERLOCKING WOOD PILING COVERED WITH CONCRETE

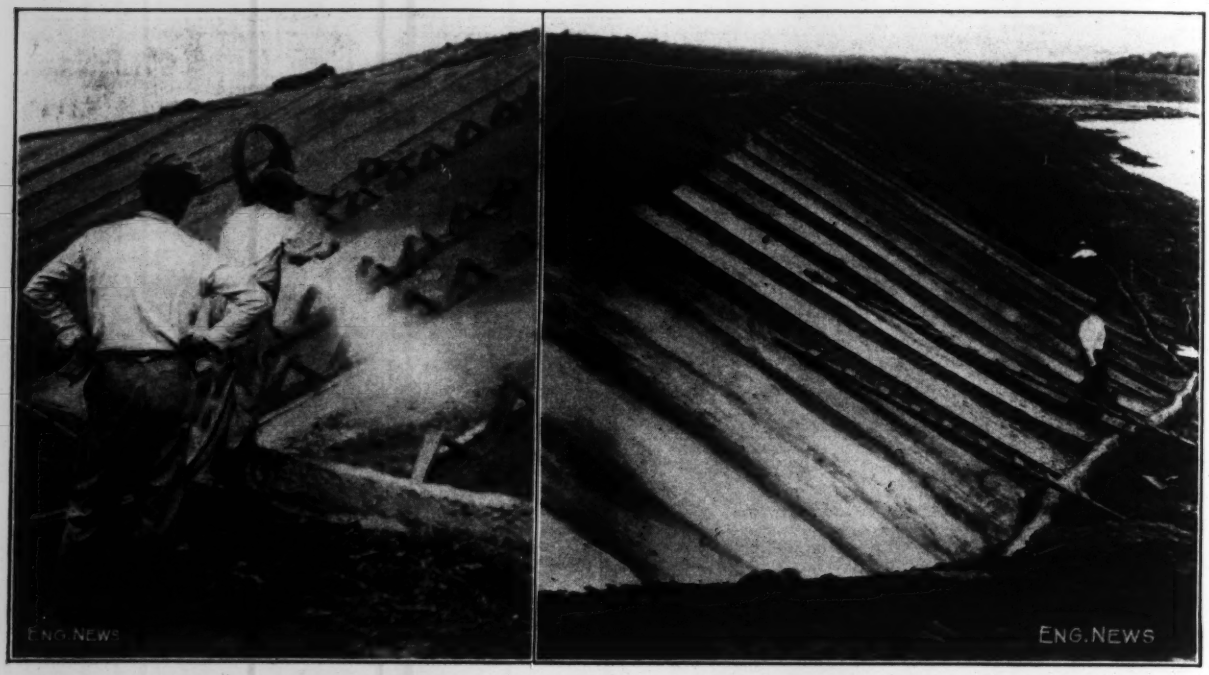


Fig. 7. Placing Gunite on Face

Fig. 8. Gunite in Place

FIGS. 7-8. GUNITE PROTECTION OF LEVEE FACE

ways: (a) Directly on the levee itself; (b) on the levee with light reinforcement; (c) on gravel spread on the levee with reinforcement on the top; (d) on gravel with no reinforcement. In each case, the top of the sheet piling was incased for one foot down with gunite reinforced by light wire mesh. The last method named, that is, gravel with no reinforcement, having proved most satisfactory, it was adopted for the bulk of the work. The gravel was spread 2 in. thick on the levee and was then treated with gunite to concrete it in place. This was found to give a dense concrete practically impervious to water, as was shown by a basin constructed by this office.

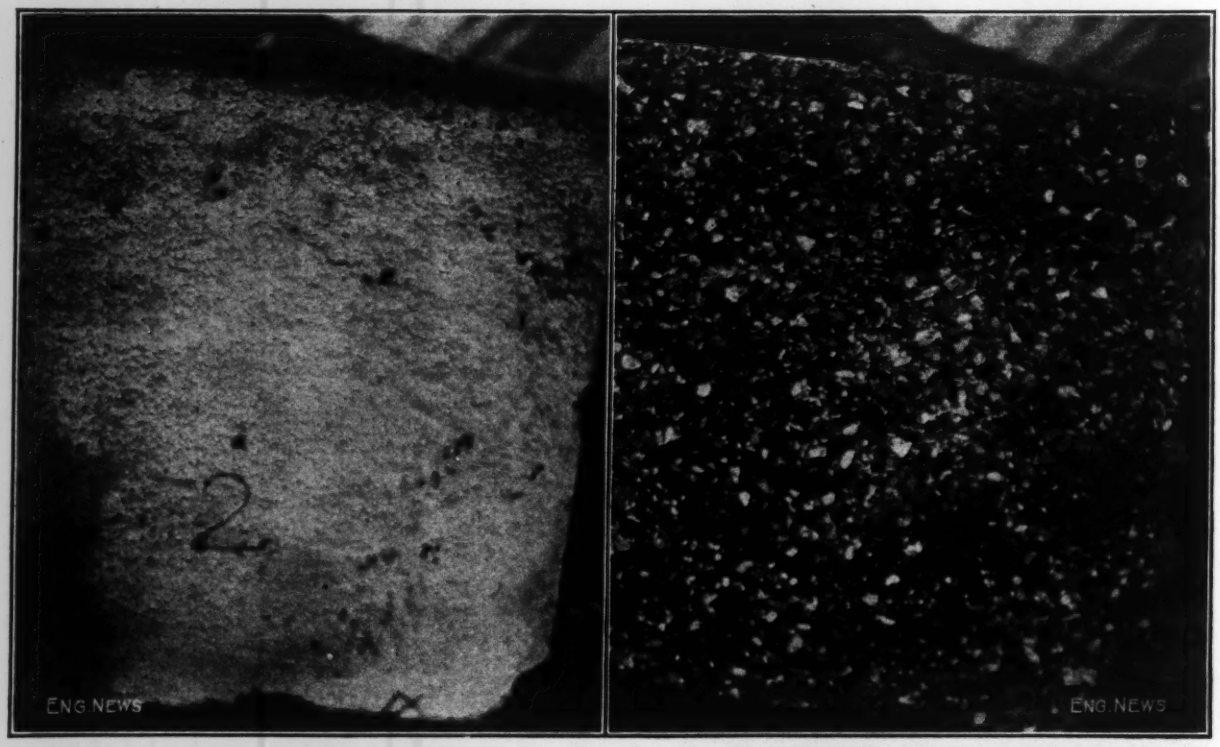


FIG. 9. TOP OF GUNITE SLAB

FIG. 10. BOTTOM OF GUNITE SLAB

This basin was hopper shaped, 4 ft. square at the top, 2 ft. square at the bottom and 2 ft. deep, and was constructed with a 2-in. layer of gravel treated with gunite. After this gunite had set, the basin was removed from its earth form, and being placed on timber supports and filled with water, it was tested as to percolation, with the result that it was found to be practically water-tight after a week's test. This mixture consisted of one part cement to 3 of sand and 3 of gravel.

After experiments in placing the gunite by the various methods mentioned above had been made, it was found that the products secured by spreading a layer of 2-in. gravel ranging from ½ to 2 in. in diameter and treating with very wet gunite of one part cement and three parts sand gave an impervious dense mixture 2 to 3 in. thick at a cost of about 33⅓% less than the ordinary 1:3:5 concrete mixture 4 in. thick.

Four sets of test wells, four wells in each set (Fig. 1), were driven and lined with porous terra cotta pipe, in order to determine the rate and amount of rise of the plane of percolation of water through the levee under the head caused by the filled basin. On account of the saturation of the levee by heavy rains previous to the filling, it was found that water in the wells driven through the center of the levee rose about 12 ft. above the natural ground surface before any water was pumped into the basin. It is proposed to continue the test during the dry fall months, in order to definitely measure the effect of protection work on the surface of percolation as compared with that in the unprotected portions.

The U. S. dredge "The Ram" pumped the basin full of water up to 41.8 ft., Cairo datum, 0.6 ft. below the 1912 high water, between July 18 and 25. On July 27, a slough occurred 80 ft. long at its base which took out 3 ft. of the crown at the point marked *X* (Fig. 1). It had been the intention to raise the water about 1½ ft. higher, but due to this dangerous slough of the old main levee, which threatened to cause a crevasse toward the river, the pumping was discontinued. At this time, the landside of the threatened main levee was blanketed with earth and the entire length of this main levee between the ends of the experimental levee was thoroughly drained on the river side to carry off the seepage as fast as possible, in order that a crevasse might not occur in this levee before the experimental sections should have had a thorough test.

On Aug. 5-6, the water was further raised to 0.4 ft. above the 1912 high water. Two days later a slough occurred at *Y* (Fig. 1), taking out 4½ ft. of the crown, and but for prompt protective work a crevasse would have occurred on this date.

The first seepage in the new experimental levee began July 23, in the standard full section unprotected levee near its junction with the main levee and has continued increasing to date. The second seepage began July 29 at the landside toe of the levee at Station 3693 behind the concrete-protected levee. The third seepage began Aug. 8 on the landside slope opposite Station 3690 + 60, about 15 ft. up from the toe. The seepage at these two places covers small areas about 6 to 8 ft. in diameter and of small amount. No seepage whatever has occurred in the small section levee itself or in the fields behind the small section levee protected with interlocking sheet piling and 2-in. gunite facing. The basin has been filled with water more than a month at this time, which is a considerably longer period than the levees are usually subjected to the strain of the highest water of the Mississippi River floods, as the extreme height is reached gradually and the water at once begins to subside. The behavior of the protected sections as compared with those unprotected indicates the superiority of protected levees of small section over the larger standard sections of earth alone.

The old main levee, although subjected to a much lower head, and though having a larger section than the protected portions, began to seep throughout its entire length shortly after the basin was filled and continued to grow worse from that time onward. The new standard section has also shown considerable seepage in its upper portion; the concrete-protected levee has seeped at only two small places. The smaller section gunite and sheet-pile protected levee has shown no seepage. The levee itself and the fields in the rear remain dry. The two seepage areas behind the concrete protection can probably be explained by the fact that in driving the sheet piling two logs, buried from 10 to 15 ft., were struck by the piles, which were badly shattered and probably did not make a tight cutoff wall at those points. It is also possible that the seepage at these points was caused by cracking of the concrete, due to the excessive subsidence of the levee where extensive slides had previously occurred and had been replaced in the construction of the levee. In localities where levees are subjected to wave-wash or where the land on which to build the levee is expensive the protection is especially valuable.

Tables have been compiled showing that for heights over 16 ft. the smaller levee with gunite and interlocking wood sheet piling with 10-ft. penetration costs less than the standard large unprotected levee. For the heights up to 16 ft., the standard small levee costs more than the large unprotected one.

Payment for Construction Charges of Irrigation Projects carried out by the Reclamation Service will hereafter be distributed over a period of twenty years, instead of ten years, as heretofore. This change is the result of a recent Act of Congress. Under the act, 5% of the construction charges against any land owner will be paid as an initial installment, and the remainder due will be paid in 15 annual installments, but the first of the 15 installments will not be due until Dec. 1 of the fifth calendar year after the initial installment. The first five of the 15 installments will be at the rate of 5% of the construction charge, and the last ten at the rate of 7%. The change in the period allowed for payment will apply to land owners under existing projects, so far as balances due are concerned; but such balances would be payable in 20 instead of 15 annual installments, the first four installments at the rate of 2% per annum, the next two installments at 4%, and the next 14 at 6% of the total construction charges unpaid when the law goes into effect. The act also prohibits any increase in the construction charges after these have once been established, except on agreement between the Secretary of the Interior and a majority of the land owners affected. The Act further provides for "an operation and maintenance charge based upon the total cost of operation and maintenance of the project, or each separate unit thereof, and such charge shall be made for each acre-foot of water delivered; but each acre of irrigable land, whether irrigated or not, shall be charged the minimum operation and maintenance charge based upon the charge for delivery of not less than one acre-foot of water." The Act authorizes the Secretary of the Interior to make general rules and regulations regarding the use of water in any project, and also authorizes him to "require the reclamation for agricultural purposes and the cultivation of one-fourth the irrigable area under each water-right application or entry within three full irrigation seasons after the filing of water right application or entry, and the reclamation for agricultural purposes and the cultivation of one-half the irrigable area within five full irrigation seasons after the filing of the water-right application or entry."

Tests of a Deep-Well Irrigation Pumping Plant

By Geo. S. Knapp*

While much of western Kansas consists of semi-arid plains having an altitude of 2000 to 3000 ft., it has an almost unlimited supply of underground water suitable for irrigation. At a depth of 10 to 60 ft. in the Arkansas Valley, and 60 to 120 ft. on the uplands, is a water-bearing gravel extending to a depth of several hundred feet. The gravel is coarse so that the water flows to the wells very rapidly. aMny of the wells furnish 2000 to 3000 gal. per min., and will supply this amount continuously without any apparent decrease in the supply.

The richness of the loam soil of the uplands, combined with the cheapness of the land and the abundance of water, have led homeseekers and capitalists to buy up these lands and convert the great ranches of a decade ago into productive fields. The United States Sugar & Land Co. has about 5000 acres, nearly all irrigated by pumping and used for growing sugar beets and alfalfa. The company is constructing a large electric power plant to supply power to the farmers for pumping.

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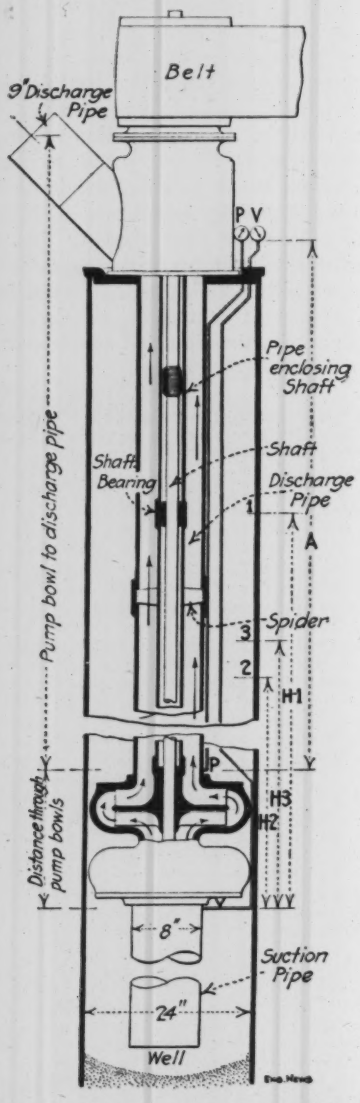


Fig. 1. Sectional Elevation of Deep-Well Pumping Plant for Irrigation at Garden City, Kan.

The field of irrigation by pumping from deep wells is a comparatively new one, and is yet in the experimental stage. The question of economical pumping is a large one and the development of efficient machinery to handle large quantities of water at the high heads will go far toward solving the problem.

There are at the present time three distinct types of pumping plants: (1) the plunger pump operated by a windmill; (2) the common horizontal centrifugal pump, used where large quantities of water are required and the head is not too great; (3) the deep-well turbine centrifugal pump. The chief advantage of the windmill plant is the low cost of operation. But in order to make use of the power whenever the wind is blowing, and to have a ready supply of water whenever it is desired to irrigate, a large and ofttimes expensive reservoir must be built. To get a sufficient supply of water, several wells may be put down around the reservoir and a windmill erected over each. It is not uncommon to see five to ten windmills pumping into one reservoir.

With the horizontal centrifugal pump, it is possible to pump water enough to irrigate directly from the pump, the plant being run only while irrigating. This saves the expense of a reservoir and eliminates the loss of water by seepage and evaporation from the reservoir. The pump is placed usually in a pit about 10 ft. below the surface to reduce the suction head, and is driven by a belt from above. With this type of plant, it is usually better to put down several small wells rather than one large one, and pipe all to one pump. Near Garden City, Kan., is a plant of this kind with five wells about 50 ft. apart, connected to one pump driven by an oil tractor. This plant has a capacity of 4000 gal. per min.

The deep-well pumping plant differs from the others principally in the type of pump used. The pump (consisting of several stages) is placed near the bottom of the well and is supported entirely by the piping, as shown in Fig. 1. The driving shaft is vertical and is inclosed in a protecting pipe inside of the discharge pipe, which serves the double purpose of protecting it and keeping it in alignment. A thrust bearing in the head carries the weight of the shaft and the revolving parts. The entire weight of the pump is carried by the head which rests on the well casing. The pump is driven either by an engine (with a quarter-twist belt) or by a direct-connected motor.

For the purpose of investigating the expense of pumping, the cost of equipment, the duty of water, and the methods of applying it, a pumping plant of this last type has been installed near Garden City, Kan., to irrigate 80 to 100 acres, and is operated by the coöperation of the U. S. Department of Agriculture and the Division of Agriculture of the Kansas State Agricultural College. In the spring of 1913 the writer spent three months at the plant and during that time made a number of tests.

Description of the Plant

The well is 24 in. diameter, 180 ft. deep, cased with No. 3 steel (U. S. gage). The lower 90 ft. of this is wire-wound strainer. A log of the well shows 47 ft. soil, 3 ft.

soft limestone, 6 ft. gravel, 2 ft. sandstone, 35 ft. No. 8 sand, 30 ft. No. 9 sand, 16 ft. No. 10 sand, balance fine sand and soft limestone. The water stands at 71 ft. in the well when the pump is not in operation, and draws down to about 110 ft. when supplying 650 gal. per min.

A two-stage pump with 8-in. suction and 9-in. discharge, has its shaft belted to a fuel-oil engine. The pump bowls are 120 ft. below the surface. Below this is 40 ft. of wrought-iron suction pipe without foot valve or strainer, this pipe being for the purpose of keeping the well free from sand. The shaft and moving parts of the pump are carried on a ball thrust-bearing in the pump head. The protecting pipe incloses babbited bearings placed 6 ft. apart to keep the shaft in alignment, and this pipe in turn is supported at 20-ft. intervals by spiders fastened in the couplings of the discharge pipe. The shaft is lubricated by the overflow from the main bearing corrugated steel. The large fuel tank is of steel and is set in a concrete-lined pit and covered with a shingled roof. A derrick over the well to assist in pulling the pump, and a few necessary tools complete the equipment of the plant. The cost of the plant is as follows:

Engine, complete on foundation		$1705
Pump, complete in well		764
Well:		
Drilling well and setting pit and strainer	$1136	
90 ft. of 24-in. strainer	900	
90 ft. of 24-in. steel pit	315	
Hauling supplies, etc	382	
Total cost of well		2733
Building		446
Storage tank		202
Belt, weir box, labor, etc		375
Grand total		$6225

Tests

A number of tests were made during the summer, but many of them either did not give results of any value or

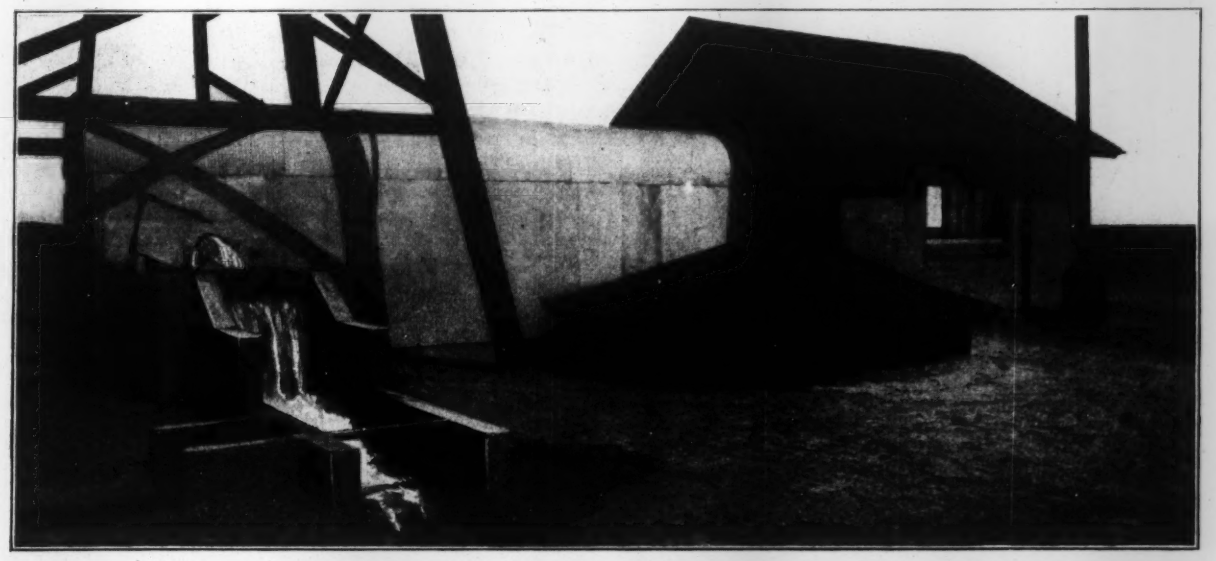


Fig. 2. Deep-Well Pumping Plant for Irrigation at Garden City, Kan.

(The oil engine is in the small house, with inclosed belt gallery to the well. The discharge from the pump flows to the concrete weir box. Adjacent to the pump house is the top of the tank for fuel oil. The derrick over the well is for handling the pump.)

at the top flowing down around the shaft. The discharge from the pump is into a concrete weir box, shown in Fig. 2, from which the water flows over a Cippoletti weir (with 24-in. crest) to the ditches.

The oil engine is horizontal, single cylinder 16x24 in., single-acting, throttle governed, and rated at 75 hp. It operates on fuel oil of about 39° Baumé and about 17,200 B.t.u. per lb. The fuel is pumped by the engine from a 10,000-gal. supply tank outside of the building and passes through coils in the exhaust pipe which heat it nearly to the boiling point before entering the carburetor. To facilitate starting, a 60-gal. tank is provided for gasoline which is used until the engine becomes warm enough to vaporize the distillate. Three-way cocks on the engine make possible an instantaneous change from one fuel to another. An additional fuel tank is provided for measuring the fuel during a test. Compressed air for starting is stored at 150 lb. pressure in two tanks having a capacity each of 4 cu.ft. of compressed air. These are charged by a small compressor driven by the engine.

The engine is housed by a concrete building, and the pump and belt way by a frame structure covered with

were not continued enough to warrant publishing the results. Several attempts were made to obtain curves of the pump, since its efficiency was low and the curves would have been of considerable value in studying the causes of the low efficiency. Nothing of any value was obtained, however, because of the limited range through which the conditions could be varied. The head could not be reduced below about 80 ft. and as there was no means of regulating it, it increased in proportion to the quantity of water pumped, due to the lowering of the water in the well. The pump speed also could not be varied, as the speed of the engine could not be changed more than about 5% above or below normal, and there was not power enough to admit of putting smaller pulleys on the pump to get higher speeds.

The two tests in the accompanying table best show the operation of the plant. The first represents the ordinary working conditions, and in the second, the conditions are improved somewhat. After the first test the valves on the engine were carefully ground and timed, and the piston rings (which were leaking badly) were turned and fitted. This resulted in such an increase in

power that it was possible to use a pulley of 2-in. smaller diameter on the pump, thus getting an increase in pump speed.

As the conditions remained practically constant during the tests, readings were taken only at 30-min. intervals, the averages or totals being taken in the final computations. The horsepower was found by indicating the engine, and the power delivered to the pump was obtained by multiplying this by the mechanical efficiency of the engine and making a correction for belt slip. A subsequent test on the engine by loading it with a rope brake gave a mechanical efficiency of 85% at the load required by the pump. The belt slip was 4.8% in the first test and 6.1% in the second. The fuel was weighed each time the small tank was refilled. The discharge over the weir was determined by measuring the head and referring to a previously prepared head-discharge curve for that weir.

TESTS OF DEEP-WELL IRRIGATION PUMPING PLANTS

	No. 1		No. 2
Duration	10 hr.		8 hr.
Engine speed, r.p.m.	187.0		173.0
I.hp.	67.7		70.2
Fuel, gal.	93.2		80.0
Pints per i.hp.-hr.	1.1		1.1
Pump speed, r.p.m.	875.0		909.0
Discharge, gal. per min.	564.0		657.0
Head, ft.	107.0		110.8
Water hp.	15.2		18.4
Efficiency of pump	28%		33%
Total water pumped, gal.	338,500		315,600
Total water pumped, acre-ft.	1.02		0.908
Cost of pumping:			
93.2 gal. of fuel at 3¾c.	$3.50	(80)	$3.00
2 gal. lubricating oil at 40c.	0.80	(1.6)	0.64
Man to tend plant	2.00		1.60
Total	$6.30		$5.77
Cost per acre-foot per foot of lift	5.9c.		5.1c.

The prices given do not include help to spread the water in the field, nor interest and depreciation on the plant. The cost of pumping was reduced considerably in the second test. This must be due to a better pump efficiency at the increased speed, since the fuel consumption of the engine was the same. From the fact that a 3.9% increase in power in the second test resulted in a 3.8% increase in pump speed and a 16.6% increase in discharge at a slightly increased head, we may conclude that the pump is operating below the most efficient speed for that head. No better speed could be obtained, however, as the engine was loaded to its maximum capacity in both tests. From the results of these tests it appears that the engine does not deliver its rated power in the belt. Probably much of this deficiency is due to the rarefied air at this altitude (2900 ft.), which reduces the volumetric efficiency of the engine. The engine comes within the manufacturer's guarantee, however, as the specifications only required the engine to deliver 60 b.hp. at this altitude.

Testing the Pump

A test of this type of pump presents some features not met with in the more common types. Gages were connected above and below the pump bowls to determine the head, the pressure gage being 120 ft. and the vacuum gage 124 ft. below the ground level. While readings were taken regularly on the gages, they were not used in computing the total head on the pump, for reasons which follow.

It is much more difficult to determine the suction head with a pump of this type than with an ordinary centrifugal pump, because the height of the water in the pipe V (Fig. 1) leading to the vacuum gage cannot be determined with any certainty. This must be known to determine the suction head. This is due to the following causes: When the pump is not running, the water in the well stands at some point 1, and there is a static head H-1 at the entrance to the pump. When the pump is in operation, the water draws down to 2, and the static head at entrance is H-2. The water in the small pipe V will not remain at 1, neither will it fall to 2, but as the pressure is reduced at the pump entrance as the pump is started, the column of water will fall and the air above it will expand until a condition of equilibrium has been obtained. This will allow the water to fall to some point 3 and the static head will be H-3, the actual head at entrance being the algebraic sum of the head H-3, and the gage reading reduced to feet.

It yet remains to find the value of H-3. This can be done by considering the expansion of the air column as isothermal and applying the law $PV = pv$ where P and p are the initial and final absolute pressures, and V and v are the initial and final lengths of the air column above the water level in the small pipe. In the second test: $V = 71$ ft.; $P = 26.7$ in. of mercury; $p = 26.7 - 7.8 = 18.9$ in. mercury. Then $v = (71 \times 26.7) \div 18.9 = 100$ ft. And H-3 $= 124 - 100 = 24$ ft. The average gage reading during the run was 7.85 in. of mercury $=$ 8.8 ft. of water. The head at the pump entrance then is $24 - 8.8 = 15.2$ ft.

In this plant the pump is submerged until there is a positive head at entrance. This method will give the true head only if no air has leaked into the pipe, for if there is any leakage, H-3 may drop until the gage will read zero even though there is a considerable suction head. This possibility of leakage makes this method very uncertain.

Another method of determining the head at the pump entrance is to find the loss of head below the pump and subtract such loss from H-2. This loss consists of the friction head in the suction pipe and the velocity head. Since there was neither foot valve nor strainer on the suction pipe, we can allow the usual friction for iron pipe for the friction head. Merriman's "Hydraulics" gives 0.3 ft. as the friction head for 40 ft. of 8-in. iron pipe with a velocity of 3.6 ft. per sec. The velocity in the suction pipe was 3.6 ft. per sec., from which the velocity head $V^2 \div 2g = 0.2$ ft. Dropping a float to the surface of the water showed that H-2 was 16.2 ft. The head at entrance then is $16.2 - (0.2 + 0.3) = 15.7$.

The head is 0.5 ft. more by this method. While there is always some uncertainty in regard to the friction head, it is always small, and the liability of error will probably be less by the latter method. This was the method used to compute the suction head in the foregoing tests.

There is no difficulty in determining the head above the pump by the use of the pressure gage. If a vent is opened at the top of the pipe when the pump is started the water will rise and expel the air, thus the head in the pressure-gage pipe to be added to the pressure-gage reading is known. It is readily seen, however, that in a pump of this type the loss of head between the pump bowls and the discharge is governed largely by the manufacturer's design. Obstructions such as the spiders to hold the protecting pipe in place, as well as the pipe itself, may cause a considerable friction head.

In a test to determine the performance of the pump proper at various heads it is desirable to have a gage im-

mediately above the pump bowls. But in a test where the object is to find the efficiency of the installation, any losses between the pump bowls and the discharge pipe should, in the opinion of the writer, be charged to the pump. Then a gage should be placed in the discharge pipe above the pump head if there is any head above that point. On this pump the discharge pipe was less than 2 ft. long, and the friction is negligible; and as there was no pressure head the velocity head can be taken as the total head at that point.

Under the former method the head is 110.8 ft., but if computed by using the pressure gage it will be 120.1 ft. This is 9.3 ft. greater, the difference representing the head lost between the pump bowls and the discharge pipe. If this were not charged to the pump the efficiency would be 36% instead of 33%, as given in the table.

Trainshed of the Kansas City Union Station

The trainshed of the new station of the Kansas City Terminal Ry., Kansas City, Mo., is of the low-roof multiple-span type now very generally used in preference to the lofty single-span arch roofs that were largely favored at one time. It has a very unique feature, however, in the use of one wide opening over each pair of tracks instead of a narrow opening or smoke slot over the center of each track. Fig. 1 is a view of the completed steel work of one span, showing the skylight covering

FIG. 1. TRAINSHED OF THE NEW UNION STATION OF THE KANSAS CITY TERMINAL RY., KANSAS CITY, MO.

and (at the right) the vertical concrete slabs forming one side of the wide ventilating opening. The slabs on the left side had not been placed. The roof and window which appear through the open top of the trainshed are part of the waiting room, which occupies a one-story building spanning the tracks.

The roof framing consists of a row of steel columns along the center of each platform, supporting longitudinal trusses of 34 ft. span and main trusses of 44 ft. span. The columns are spaced 34 ft. apart longitudinally and the main trusses 17 ft., the intermediate trusses being carried by the longitudinal trusses. Over the outer platform there is an extension of the roof supported by cantilever trusses. The main trusses have in-

Piles of Unusual Length are to be driven to support the falsework of the Mississippi River Bridge which is under construction for the Rock Island R.R. at Memphis, Tenn. An order for 120,000 lineal feet of piling is being filled in the coast forests of Oregon. Some of the piles are 114 ft. in length. The felling and handling of these very long slender timbers is a task of no small difficulty. The piles are shipped out of the woods on a logging railroad with 15° curves, which is about the limit of curvature over which such long piles could be handled. For shipment east, the piles are loaded on flat cars with an intermediate idler car.

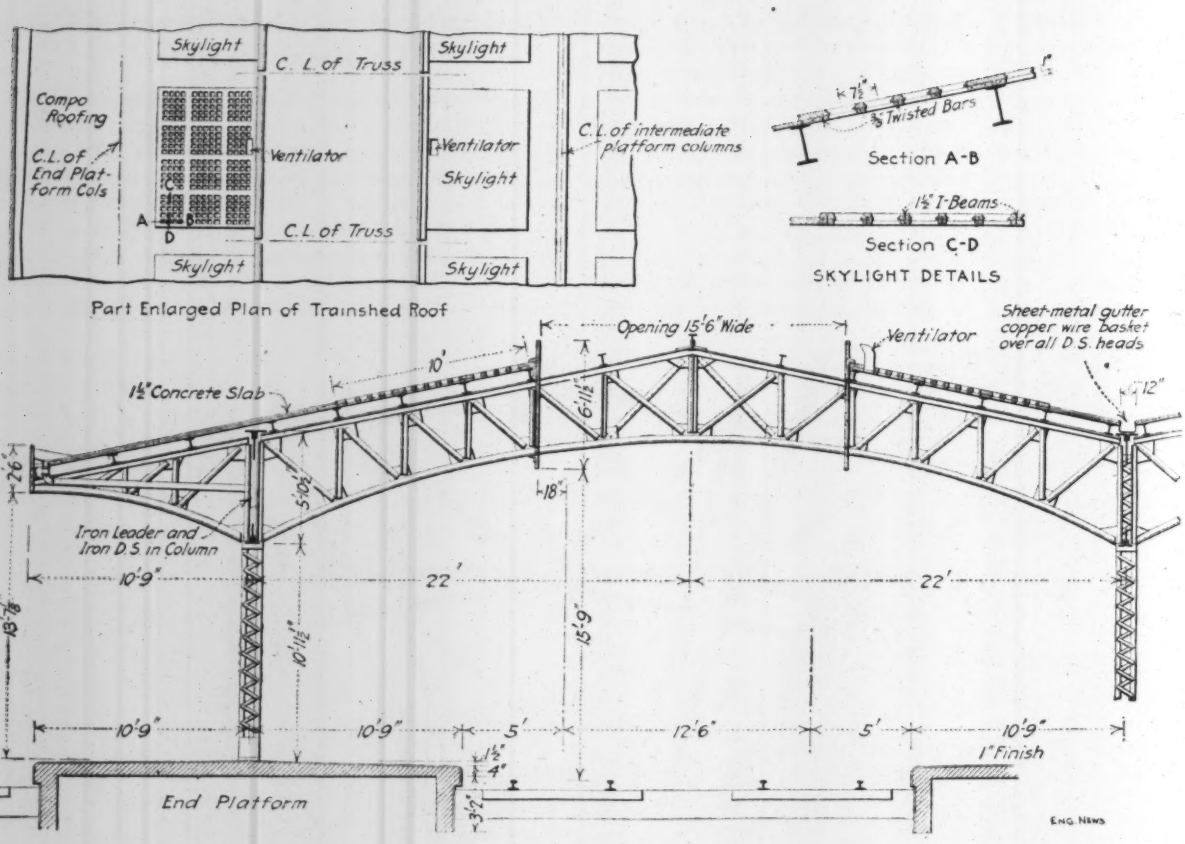


FIG. 2. SECTIONAL ELEVATION OF THE TRAINSHED OF THE NEW UNION STATION, AT KANSAS CITY, MO.

clined top chords and curved bottom chords, with a clear headway of about 17 ft. 3 in. above rail level at the center of spans and about 11 ft. minimum at the platforms. The top chord supports the I-beam purlins, which in turn support the roof slabs.

The major part of the roof covering consists of skylights of the sidewalk or vault type, having glass prisms set in concrete frames. The remainder of the covered area has 1½-in. slabs of reinforced concrete (about 26x46 in.), with composition roofing. The steel work is painted a gray color for the finishing coat. The exposed steel in the openings over the tracks is to be protected by a 2-in. coating of cement mortar on wire netting of ½-in. mesh. This coating will be applied by the cement-gun method.

The open space in each span is 15 ft. 6 in. wide, with sides formed of vertical concrete slabs 1½ in. thick, 26 in. wide and nearly 7 ft. high, having a back rib which rests on the roof covering. These are to afford protection to the platforms, and while in a driving rain this will not be so complete as with the narrower openings or smoke slots of other designs, the platforms are so wide that it is thought there will be no trouble in protecting passengers on their way to and from the trains. The engineers considered a trainshed of the Bush type with narrow slots (as used at the Chicago & Northwestern Ry. terminal in Chicago and the Delaware, Lackawanna & Western Ry. terminal at Hoboken), but it was decided that the type with wide openings was better adapted to the climatic conditions of Kansas City. It would be an easy matter to alter the trainshed to the narrow-slot type if this should prove desirable, but there is no expectation that this will be the case.

The trainshed was designed by Jarvis Hunt, of Chicago, architect for the station, with advice and suggestions from John V. Hanna, Chief Engineer of the Kansas City Terminal Ry. It was built by the Geo. A. Fuller Construction Co., of New York, the Strobel Steel Construction Co., of Chicago, being the sub-contractor. The station has 16 tracks (with provision for eight more), each long enough for two trains (running in opposite direction). It was described very fully in ENGINEERING NEWS, Aug. 7, 1913. It is expected to be officially opened for traffic before next winter.

Construction Work Discontinued on Swiss Railways—General stoppage of construction work in Switzerland immediately after the outbreak of the European war produced widespread unemployment, in spite of the fact that the entire army is mobilized and engaged in frontier guard service. Recently, the Swiss Federal Rys. stopped all construction work on their lines and began proceedings to cancel construction contracts and material contracts wherever possible. A large reduction in forces is to be made Oct. 1 and Nov. 1. These steps result from a fear that even after the close of the war, the traffic will remain far below normal, and both the decreased traffic and the decreased receipts would remove the need and justification for construction improvements. Swiss engineering societies have begun to agitate against this, however, and are urging that public authorities should continue all work in progress, largely to avoid increasing the amount of unemployment, and to check the spread of business contraction and panic. Some of the cities and cantons have already acted in accordance with these recommendations.

A Tight Job of Water-Main Laying at Akron, Ohio*

By E. G. Bradbury†

In designing the extensive improvements to the water-works of Akron, Ohio, F. A. Barbour [Boston, Mass.] and the writer specified, after much consideration, a maximum permissible leakage of 200 gal. per inch-mile daily —equivalent to about 1.6 gal. per ft. of lead joint.

The pipe laid at Akron comprises new supply lines, lines paralleling and reinforcing old mains of insufficient capacity, and extensions into streets not heretofore furnished with water. The new supply lines and reinforcing mains are laid by contract under the supervision of the designing engineers, E. A. Kemmler, Department Engineer, being in immediate charge, while the extensions are laid by employees of the city under H. H. Frost, Superintendent of Water-Works. All pipe is purchased by contract and is inspected at the foundry by experienced men. The depth of lead specified is 2¼ in.

The method used in all tests was as follows: After completion of laying, the pipe was filled with water and usually allowed to stand for about 24 hr. to permit the yarn in the joints to become saturated. The pipe having been tapped for a ¾-in. connection, a small hand pump was connected by wrought-iron pipe and fittings, on which a gage was set, the suction being placed in a barrel of water. All gates were then closed and a hydrant valve opened to determine whether gate leakage existed in amount sufficient to flow. The depth of water in the barrel and its diameter at water level were then measured and pumping begun. If the pressure was readily raised to the required amount the time was noted, and the amount of water required to hold the gage stationary for a period of from 10 to 30 minutes carefully observed. The leakage was computed from the quantity so used. If too great difficulty was found in raising the pressure, or if the leakage was found to exceed the allowed quantity, pumping was stopped and the gage observed to see it if would remain stationary after dropping to city pressure, thus indicating gate leakage; if such leakage was not demonstrated, effort was made to find defects in the pipe. In one or two instances pipe which could not be pumped up to pressure on the first trial were successfully tested on the following day, no satisfactory explanation being found. In a considerable number of cases the contractor was required to locate leaks and recalk joints, sometimes causing the reopening of the trench for considerable distances. In two cases, cracked pipe were located and removed.

The final results of the tests have been very gratifying. A total of 100 tests have been made of pipe laid by contract, of which 86 are included in the accompanying table. Of the remaining 14, there were eight in which all joints were visible and no leakage existed, but on account of loss through gates, no measurement was made; three in which the measured loss somewhat exceeded the specified maximum but evidence of gate leakage was such as to satisfy the engineers that the specifications were complied with; and three in which the leakage was above the specified amount and the work not accepted. Of 40 tests made by the superintendent of water-works of pipe laid by his department employees, 38 have been tabulated, the remaining two exceeding the permissible loss; these are to be dug up if necessary to locate and repair the leaks.

TABLE I. SUMMARIZED RESULT OF TESTS OF PIPE LAID BY CONTRACT AND BY THE SUPERINTENDENT OF WATER WORKS, AKRON OHIO

Size, in.	Length, ft.	Leakage, gal. daily per in.-mi.	Number of tests
86 TESTS OF PIPE LAID BY CONTRACT*			
4	717	23	1
6	31,066	66	34
8	6,882	42	6
10	5,123	81	5
12	9,704	102	8
16	8,792	135	11
20	8,389	69	10
24	3,358	69	3
30	14,445	82	8
	88,476 (16.76 mi.)	83.4	86
38 TESTS OF PIPE LAID BY SUPERINTENDENT OF WATER-WORKS			
6	37,524	59	32
8	6,509	63	5
10	2,859	133	1
	46,883 (8.9 mi.)	61.7	38

*Pressure from 66 to 152 lb.—35 greater than static head when improvements are complete.

All the above figures are probably high, as they include whatever leakage may have occurred through gates, as well as actual loss. Such leakage was known to exist in many cases, and in 20 of the tests of pipe laid by contract and included in the above summary, every joint was visible and tight, although usually some water was required to keep up the pressure. The amount pumped also covers any contraction or absorption of air contained in the pipe. The presence of any considerable amount of air makes the tests unsatisfactory and occasionally it becomes necessary to tap the pipe to release it.

Check tests of 24- and 30-in. pipe, made several months after the original test in two districts of about one mile each, verified closely the previous work, showing losses of 55 and 79 gal. per in.-mi., respectively.

Assuming the average diameter of pipe in a complete system to be 9 in., each 100 gal. daily per in.-mi. saved or lost has a value of $3.28 per year for each mile of pipe at a production cost of $10 per million gallons, or, capitalized at 7%, is worth $46.86. Applying these figures to a concrete example, a city of 100,000 population with a production cost of $25 per million gallons, and 160 miles of mains, would gain $5626 per year by a saving of 400 gal. per in.-mi., and figuring interest and sinking fund at 7%, could afford to have spent $75,100, or about $470 per mile more on construction to accomplish this result, and the same amount lost per inch-mile would cost a city of 200,000 population with 300 miles of mains and a production cost of $50 per million gallons $19,700 per year—equal to an investment of $281,430.

The expense of testing in the manner described is not heavy, averaging about $50 per mile. Occasionally, where careless work has been done and the pipe covered, the contractor foots a rather heavy bill of expense, but the knowledge that the work is to be tested discourages carelessness and most of the tests are made quickly and without trouble.

In view of all the above facts the writer proposes as a standard for allowable leakage in new cast-iron water pipe, an average of 100 gal. per mi. per in. of diameter for each complete contract or district, with a maximum limit of 200 gal. per mi. per in. of diameter not to be exceeded in any single test. The recommendation

*Extracts from a paper, "Allowable Leakage from Water Mains," read before the New England Water Works Association, September, 1914.

†Civil Engineer, Columbus, Ohio.

is made, however, that open-trench testing, with all joints visible, be specified, covering being done only by special order, and the allowable leakage clause used only when it is entirely impracticable to keep the ground open.

A Reinforced-Concrete Pile with Special Provisions for Jetting

A specially designed reinforced-concrete pile has recently been used in the reconstruction of the Platte River Bridge of the Chicago, Burlington & Quincy R.R. at Ashland, Neb. This pile is peculiar in that special interior piping is provided whereby a water jet is not only directed through the bottom of the pile downward, but upward through various openings on the side of the pile. It is known as the Bignell pile and is controlled by the Bignell Piling Co., of Lincoln, Neb.

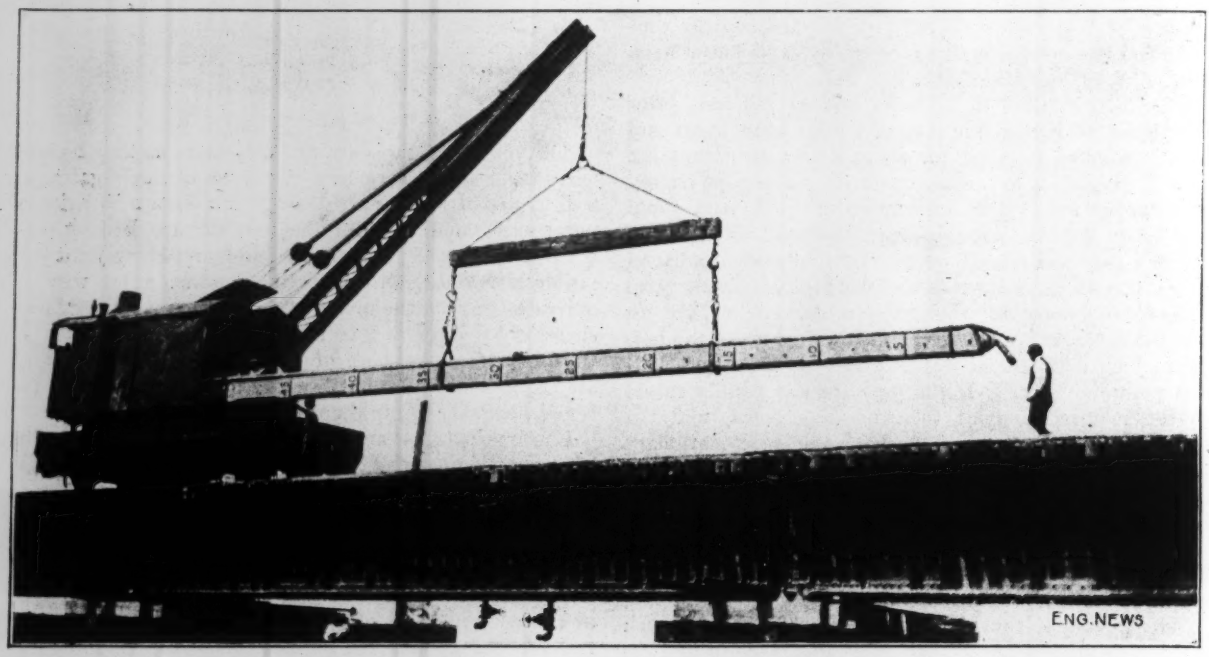


FIG. 1. SWINGING A BIGNELL PILE INTO PLACE

Fig. 2 gives the details of the Bignell pile used on the Platte River Bridge. These piles are 15 in. square, 50 ft. long and wiegh complete 6.2 tons. Each pile has a 4-in. pipe through its entire length, which pipe is reduced to 1⅛ in. at the bottom by the special nozzle given in detail in Fig. 1. The 4-in. pipe is tapped by ¾-in., ½-in. and ⅜-in. pipes, which are fitted with elbows turned up on the outer edge of the piling and are spaced at 1½, 2, 4, 8 and 12 ft., respectively, from the bottom, thus furnishing five openings on each side of the pile. In addition, a 2-in. pipe extends through the 4-in. pipe and fits into the 1⅛-in. brass nozzle at the point.

Through the 2-in. or digging pipe water is conveyed under pressure high enough to erode the material at the pile point. An independent stream with about two-thirds the pressure of the digging stream is connected with the 4-in. pipe and passes through the elbows along the face of the pile, to elevate the material eroded and to incase the pile in a film of water. After the pile is in place in the foundation the 2-in. pipe for the full length is withdrawn and the fittings at the top disconnected for use elsewhere.

Water is supplied at a pressure of 100 to 150 lb. per sq.in. in the 4-in. pipe, and 200 to 300 lb. per sq.in. in the 2-in. pipe, the high pressure being used to loosen and displace the sand and the lower pressure being just sufficient to keep the sand loose and give the upward movement sufficient to overcome side friction. On the Ashland bridge hydraulic pressure is obtained from one Knowles Special 20x8x18-in. duplex pot-valve pump furnishing high pressure through 800 ft. of 6-in. wrought-iron pipe and one Dean Bros. 16x8x18-in. duplex pump furnishing the lower pressure to an 8-in. pipe of the same length.

The average time to sink a 50-ft. pile is about 42 min. The actual time required in sinking 36 piles for one of the piers varied from something less than 14 min. to 1 hr. and 50 min., the average being 42 min. per pile. The general average for sinking the piles on the bridge is somewhat lower than this. The material encountered consisted principally of sand, grading from fine to coarse, with a mixture of gravel, some cemented gravel and some clay. Rock was from 60 to 80 ft. below the surface of the water and the piles were sunk to rock so that the tops were in general about 10 ft. below the water level. They are all driven within a coffer-dam, from which after the piles were driven the sand is removed sufficiently to escape about 2 ft. of the piling which is then embedded in concrete to form the foundation for the pier.

The maximum time required to sink one pile—1 hr. 50 min.—was due to encountering a large amount of riprap dumped in cribs around the old timber piers.

The piles were handled by a locomotive crane as shown in Figs. 1 and 3, Fig. 1 showing the pile on the swing and Fig. 3 showing it after having been jetted about 13 ft. down.

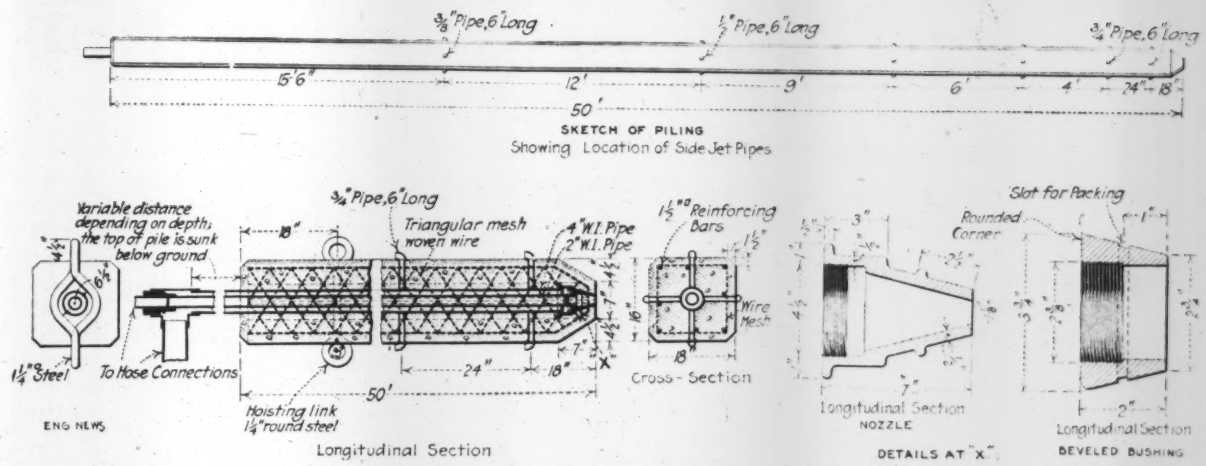


FIG. 2. DETAILS OF THE BIGNELL REINFORCED-CONCRETE PILE

The cost of manufacturing piles used on the Platte River Bridge was 53c. per lin.ft., excluding the cost of freight on the material. The piles were cast at Havelock, Neb., for convenience in using the yard equipment and were brought some 24 mi. on flat-cars to the job. The cost of sinking the whole is not known since the cost statement for work at the bridge includes work and material not charged for the sinking of piling. An estimate based on labor amounting to $10 per day and a liberal amount for the use of equipment and overhead charges gives the cost of sinking not to exceed 15c. per lin.ft., where the job amounts to not less than 10,000 ft. of piling. For a small job the total cost of piling in place is estimated to be about $1 per ft. up to lengths of 50 ft.; $1.07 for piling 80 ft. long, and 59c. per sq.ft. for sheet piling; which is of similar general design as the square piling shown, but which is provided with tongue-and-groove sides for the joints.

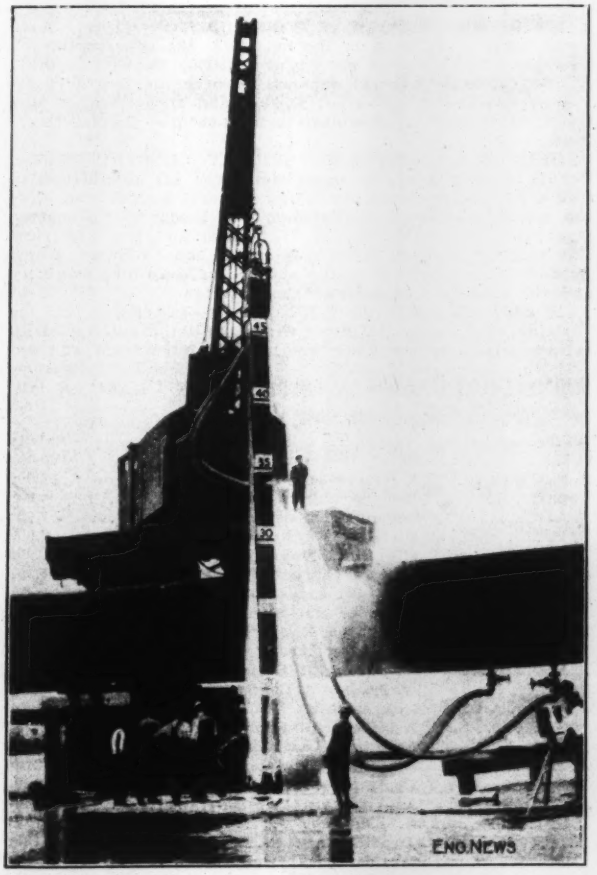


FIG. 3. A BIGNELL PILE BEING WATER-JETTED INTO PLACE

(Note water spurting from side nozzles).

Water Storage in the Naugatuck Valley, Conn., for the benefit of manufacturers and others, has been under consideration for some time past by a committee representing the manufacturers. Continuing the information given in a note published on p. 1221 of our issue of May 28, 1914, it may be stated that Charles H. Preston, Jr., consulting engineer, of Waterbury, Conn., has been engaged to make surveys, maps, borings and soundings for the project. Of several schemes available for storage purposes, Lead Mine Brook has been chosen for possible development, and the surveys will be conducted at three possible sites chosen on this stream. Preliminary estimates indicate that three reservoirs could be provided by the construction of dams at a total cost of about $1,000,000. These reservoirs would have a combined storage capacity of about 23,000,000,000 gal. Lead Mine Brook enters the Naugatuck River near Thomaston.

The Malleable Iron Industry dates from a patent obtained in 1804 by an Englishman, Samuel Lucas. In the United States, Seth Boyden first made malleable castings in Newark, N. J., in 1826. About 250 firms in this country now produce malleable castings, the total output being about 1,000,000 tons per year. The industry is almost exclusively an American one, malleable iron being made in Europe only on a very limited scale. The most rapid growth in the industry has occurred during the past twenty years. In that time malleable iron has almost entirely replaced cast iron in freight car construction and in agricultural implement manufacture. A good malleable iron should have a tensile strength of 35,000 to 55,000 or even 60,000 lb. per sq.in., with an elongation of 3% to 8% in 2 in. The above statements are taken from a paper on malleable iron read by J. P. Pero at the Chicago meeting of the American Foundrymen's Association on Sept. 7. Mr. Pero further says:

Its greatest advantage is the fact that the metal is not subject to crystallization or fatigue, but will stand as severe a test after twenty or twenty-five years of use as it will when originally made, no matter how great the vibration may have been to which it has been subjected.

If proper care is used in its manufacture, it should also be quite free from internal flaws, such as blow holes or shrinkage flaws, and the metal, while it will stand considerable abuse and distortion before breaking, is much more rigid and will resist the tendency to become distorted to a greater extent than either drop forgings or steel castings of the same sections.

Malleable iron also resists rusting or corrosion very much better than either wrought iron and steel, running only slightly below cast iron in its resisting qualities to oxidation.

The New York Rapid Transit Railway Extensions

II--Organization and Personnel of the Engineering Staff*

Few people, even in New York City, realize the gigantic task of constructing 230 miles of rapid-transit lines into and through the heart of the most congested districts of New York City—a system of elevated and underground electric railways of far greater mileage and more complete in every respect than any similar system in the world. This work is being carried on under the direction of the Public Service Commission of the First District of the State of New York, which besides having direct charge of the construction of these new Rapid Transit lines also supervises the operation of all Public Utilities companies; inspects and passes upon equipment, services and rates of all existing transportation lines, whether, Surface, Rapid Transit, Interurban or regular steam railroads, etc.,etc., as well as gas, electric light, power and telephone companies.

Organization

The chart, p. 729, shows graphically the organization of the engineering staff engaged in subway and rapid-transit design and construction and incidental work. Not shown on the chart is an Electrical Engineer, the head of a separate bureau of some 60 engineering employees, a bureau of gas and electricity, and a transportation bureau, each employing several engineering inspectors. The titles of the various employees and the salaries of each grade are shown in a table accompanying the chart.

Complex as the organization appears, it is founded on strictly military principles. There are two grand divisions, roughly the groups on the right and left respectively: (1) the actual supervision of construction, under Robert Ridgway, Engineer of Subway Construction; (2) the administrative and executive work, design, subsurface structures, estimates, etc., under Daniel Lawrence Turner, Deputy Engineer of Subway Construction. Through these lieutenants all the various subordinates report, except the Electrical Engineer, who reports directly to the Chief Engineer. To each subordinate is designated his explicit authority and responsibility, to which he is held strictly accountable.

Efficiency Records—To foster enthusiasm and assure promotion to the deserving, a quarterly record is kept of each employee's ability rating and efficiency rating as determined by his immediate superior. Each rating has an established value which is added to or subtracted from the employee's efficiency percentage. The system is quite elaborate, but has been in service for more than four years and is giving eminent satisfaction. It is the aim of the Chief Engineer to fill all the responsible positions by promotion, and whenever a vacancy occurs, promotion examinations are held, which are open only to those who have served in lower positions for a predetermined period of time and have maintained an efficiency record of at least 60%, for a given period.

Promotion Examinations—An example of such an examination was one held a year ago for the position of Assistant Division Engineer. This was open only to Assistant Engineers and Designers of Grade 10. The subjects of the examination and the relative weights were: (a) A paper on some subject relevant to the work of the applicant, weight 1; (b) efficiency, weight 3. The paper was to be typewritten and illustrated with drawings or photographs, and accompanied by an affidavit to the effect that it was an original composition of the applicant. The practicability of such a test is readily appreciated and illustrates how an enthusiastic, loyal and efficient staff may be built up and maintained, while still keeping strictly both to the letter and the spirit of the civil-service laws.

Duties of Each Rank—The specific duties of the members of each rank (in the subordinate positions there are several grades in each rank according to salary) are given below:

CHIEF ENGINEER—In general charge over all work under the Engineering Department, including the preparation of plans for and the construction of subway and elevated work by the City, and the approval of plans for and supervision over the construction and equipment of subway and elevated lines by the operating companies under the Dual Contracts, aggregating a total cost of nearly $350,000,000.

ENGINEER OF SUBWAY CONSTRUCTION—Deputy having general supervision in the field over the construction of all subway and elevated work prosecuted by the City or companies, including general supervision over the five field divisions and the Divisions of Sewers and Inspection of Material. Acts as Chief Engineer in the absence of Chief Engineer.

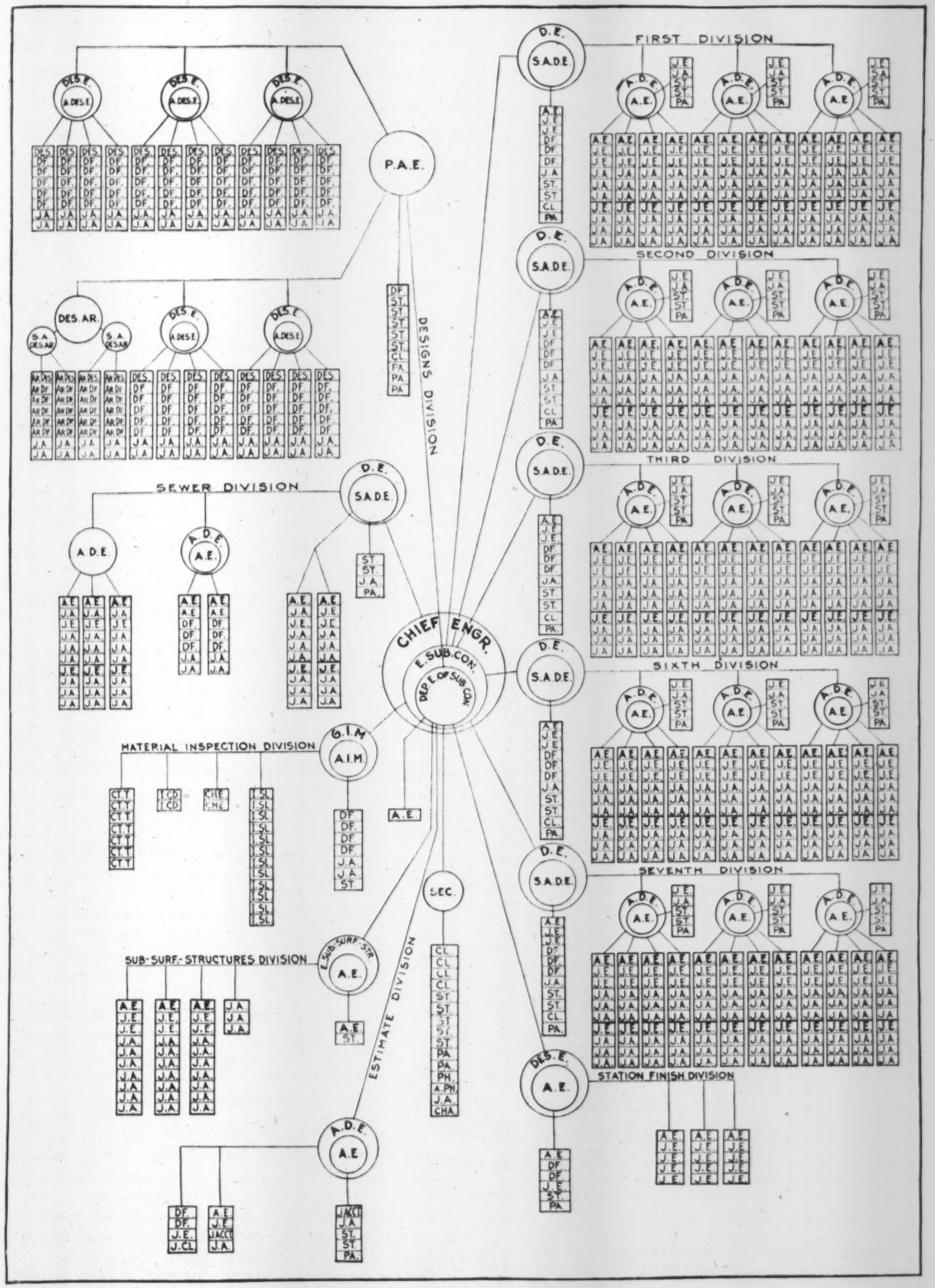
DEPUTY ENGINEER OF SUBWAY CONSTRUCTION—Deputy having general supervision over all administrative and organization work, including general supervision over the general office and Divisions of Designs, Subsurface Structures, Track Work and Estimates, and the Electrical Engineering Division with respect to new subway work. Acts as Chief Engineer in the absence of the Chief Engineer and the Engineer of Subway Construction.

PRINCIPAL ASSISTANT ENGINEER—In charge of the Division of Designs. In direct charge of the designing of all subway and elevated work and preparing contract and de-

Abbreviations Used on Organization Chart on Opposite Page

Abbreviation	Title	Salary
C. E.	Chief Engineer	$20,000
E. Sub. Con.	Engineer of Subway Construction	12,000
Dep. E.	Deputy Engineer	8,000
P. A. E.	Principal Assistant Engineer	7,000
D. E.	Division Engineer	7,000
Elec. E.	Electrical Engineer	6,000
G. I. M.	General Inspector of Materials	4,500
A. I. M.	Assistant Inspector of Materials	2,400
E. Sub. Surf. Str.	Engineer Sub-Surface Structures	4,500
Des. E.	Designing Engineer	3,750
Des. Ar.	Designing Architect	4,200
S. A. D. E.	Sr. Assistant Division Engineer	4,200
S. A. Des. E.	Sr. Assistant Designing Engineer	4,200
S. A. Des. Ar.	Sr. Assistant Designing Architect	3,750
A. D. E.	Assistant Division Engineer	3.750
A. Des. E.	Assistant Designing Engineer	3.750
A. E.	Assistant Engineer	1801-2700
Des.	Designer	1801-2400
Ar. Des.	Architectural Designer	1801-2400
J. E.	Jr. Engineer	1201-1800
Df.	Draftsman	1201-1800
Ar. Df.	Architectural Draftsman	1201-1800
J. A.	Jr. Assistant	901-1200
Che.	Chemist	901-2700
I.	Inspector	901-2700
T.	Tester	901-2700

*Although this article was prepared by the editors of "Engineering News," it is made a part of the series of articles by Mr. F. Lavis on the construction of the new subway and elevated lines in New York City, now running in this journal in order that the presentation may be complete as a whole.



ORGANIZATION CHART OF THE ENGINEERING STAFF OF THE PUBLIC SERVICE COMMISSION

tailed plans with respect thereto, and also examines and passes upon construction plans for work prosecuted by the operating companies.

DIVISION ENGINEER—In direct charge of a division of construction work in the field covering subway and elevated construction. Has charge of construction work amounting to from $30,000,000 to $35,000,000.

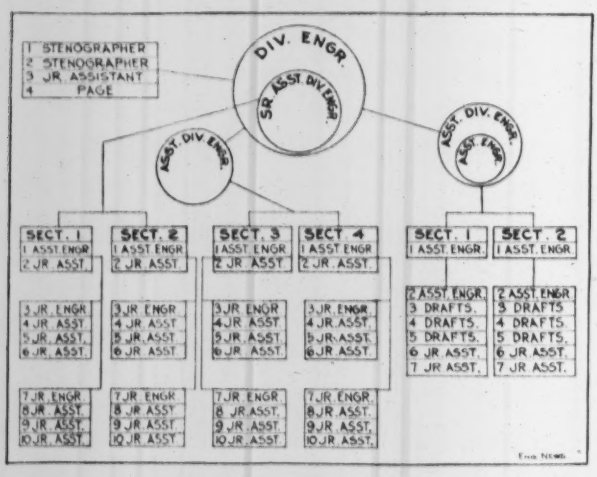
DIVISION ENGINEER OF SEWERS—In charge of Sewer Division, having direct charge of the preparation of designs and plans and supervision in the field over all sewer reconstruction work resulting from subway or elevated construction.

ENGINEER OF SUBSURFACE STRUCTURES—In charge of the Division of Subsurface Structures. In direct charge of the preparation of all designs and plans covering the reconstruction and readjustment of all sub-surface structure work in connection with the construction of subway and elevated lines.

GENERAL INSPECTOR OF MATERIAL—Has direct charge over the inspection of all materials of construction.

SENIOR ASSISTANT DIVISION ENGINEER—In charge of administrative work of a field division, under the Division Engineer. Acts as Division Engineer in the absence of Division Engineer.

ASSISTANT DIVISION ENGINEER—In direct charge of a subdivision of field work under the Division Engineer consisting of four contract sections of subway or elevated construction, covering work amounting to from $10,000,000 to $12,000,000.



ORGANIZATION CHART OF THE SEWER DIVISION OF THE PUBLIC SERVICE COMMISSION

ASSISTANT DIVISION ENGINEER—In charge of Estimates Division, under the Deputy Engineer of Subway Construction, having direct charge of the compilation and preparation of Chief Engineer's determinations with respect to the cost of construction and cost of equipment of all railroads constructed by the City and by the operating companies under the Dual Contracts and Certificates.

SENIOR DESIGNING ENGINEER—In charge of administrative work of Designs Division, under Principal Assistant Engineer. Acts as Principal Assistant Engineer in the absence of Principal Assistant Engineer.

DESIGNING ENGINEER—In charge of a subdivision in the Designs Division, under the Principal Assistant Engineer, having direct charge over the designing of subway and elevated work and the examination of designs and plans prepared by the operating companies.

ASSISTANT DESIGNING ENGINEER—Assistant to Designing Engineer in the Designs Division. Acts as Designing Engineer in the absence of the Designing Engineer.

DESIGNING ARCHITECT—In direct charge of the architectural design in connection with subway and elevated work under the Principal Assistant Engineer.

SENIOR ASSISTANT DESIGNING ARCHITECT—In charge of administrative work in connection with designing, under Designing Architect. Acts as Designing Architect in the absence of Designing Architect.

ASSISTANT DESIGNING ARCHITECT—In direct charge of a subdivision, under the Designing Architect, in the designing work and the examination of designs and plans prepared by the operating companies.

ASSISTANT ENGINEER—In direct charge in the field of the details of construction of one contract section of subway or elevated work, under the Assistant Division Engineer, approximating $1,000,000 to $3,000,000 in cost.

JUNIOR ENGINEER—Has charge of the administrative work of a contract section or of a field party giving lines and grades, under Assistant Engineer.

DESIGNER—In charge of a squad of Draftsmen and Junior Assistants in computing and preparing designs and plans, under Assistant Designing Engineer.

DRAFTSMAN—Does detail work in preparing designs and plans, under Designer.

ARCHITECTURAL DESIGNER—In charge of a squad of Architectural Draftsmen and Junior Assistants in computing and preparing architectural designs and plans, under Assistant Designing Architect.

ARCHITECTURAL DRAFTSMAN—Does detail work in preparing architectural designs and plans, under Architectural Designer.

JUNIOR ASSISTANT—Acts as a member of field party giving lines and grades, under Junior Engineer; or does detail work on tracings, plans, etc., under Draftsman or Architectural Draftsman.

CHEMIST—Makes chemical analyses of materials, under the General Inspector of Material.

CEMENT TESTER—Tests cements, under the General Inspector of Material.

INSPECTOR OF STEEL—Inspects the manufacture and fabrication of steel at the mills and shops and the erection of the steel in the field, under the General Inspector of Material.

INSPECTOR OF CONDUITS—Inspects the manufacture of conduits, under the General Inspector of Material.

CHIEF CLERK—Secretary to Chief Engineer. Has direct supervision over Engineering Department general files and clerical and stenographic work in the general office, under the Deputy Engineer of Subway Construction.

ASSISTANT CHIEF CLERK—Has charge of filing and clerical work under Chief Clerk.

The lowest engineering grade is that of Junior Assistant, with an entrance salary of $901, with promotion to $1200 without change of rank. By passing the requisite examinations and fulfilling the efficiency conditions, the Junior Assistant is eligible to the position of Junior Engineer at a salary of $1201 to $1800, or the same rank in the drafting-room force, and so on; so that a capable man is assured of reasonable progress as his value increases. The Junior Assistant corresponds to the rank of axman, rodman, chainman, etc., in other city work, but is better paid.

DIVISION ORGANIZATION—Each field division in itself requires an elaborate suborganization, as shown in the chart, p. 729, the organization chart for the sewer division will also serve as an example to illustrate how the military scheme is followed out in more detail. There are at present five field Division Engineers, each with such a semi-independent organization as shown. Each field division comprises approximately $25,000,000 to $30,000,000 in work, the division being so made rather than to contain a certain mileage or a geographical district.

The field divisions are subdivided as follows: three subdivisions, each in direct charge of an Assistant Division Engineer; each subdivision into four sections, each comprising a normal contract of from $1,000,000 to $3,500,000, each section being in charge of an Assistant Engineer. The sections, like the divisions and subdivisions are groups of construction work of approximately the same character or cost, rather than divisions of length. Each Assistant Engineer has, under the full organization scheme, 4 Junior Engineer assistants, and the 4 Junior Engineers have 5 Junior Assistants, the lowest engineering grade on the staff. A section usually covers a distance of from 2000 to 3000 lin.ft. of trackway.

Besides the salaried engineering staff of each division, there are about two masonry inspectors of construction

to each section, who are paid $4.50 to $5.50 per day, and who are not included in the organization scheme. The inspectors report to the Assistant Engineers in charge of their respective sections.

A similar scheme of subdivision exists in the office divisions of inspection of material, subsurface structures, station finish and estimates, and the divisions of design and of sewers. The various designers and draftsmen are divided into groups and squads in charge of Division Engineers, Assistant Division Engineers, Designers, etc., with ranks, grades and salaries corresponding to the field positions. Positions such as the one previously noted for Assistant Division Engineer are usually open to both field and office men, so it is possible for a man to be promoted from office to field, or *vice versa*.

Work of the Engineering Staff

It is almost impossible within a brief space to give an adequate idea of the breadth and scope of the engineering work the Public Service Commission's engineers are called upon to perform. The rapid-transit work alone requires careful surveys of the streets and subsurface structures, the examination of buildings before and during the construction of subways on account of the possibility of damages, the preparation of contract and detail plans, the examination of steel plans, the testing and inspection of materials such as cement and steel at the mills where they are manufactured, the close supervision of the construction work as it progresses, the preparation of the estimates upon which the payments to contractors are made, the redesign and construction of sewers and other subsurface structures, the passing upon all the equipment for the operation of the new railways, and other problems too numerous to mention. Besides these there are the disposition of complaints, the maintenance of existing subsurface structures and street traffic to be looked after during the period of construction.

The rapid-transit construction work has been outlined in 15 steps, as follows:

(1) Preliminary survey of streets to be traversed.
(2) Preparation of route maps and resolutions.
(3) Application to and approval by the Board of Estimate and the Mayor.
(4) Consent of property owners or of the Appellate Division.
(5) Survey of surface and subsurface structures.
(6) Preparation of contract plans.
(7) Preparation of form of contract.
(8) Public hearing on form of contract.
(9) Approval of form of contract by Corporation Counsel.
(10) Advertisement for and receipt of bids.
(11) Acceptance of bids and submission to Board of Estimate for approval and appropriation.
(12) Execution of contract and commencement of work.
(13) Preparation of working plans and examination of the working steel plans.
(14) Preparation of record plans.
(15) Arbitration of disputed items of cost.

The rapid-transit construction work cannot be compared with the work of any other commission in this country except the Boston Rapid Transit Commission, but it must be remembered that besides construction work, the Public Service Commission of the First District also performs the regulatory work of supervising all the public services of the Greater New York District, the transportation, gas and electric businesses of which amounts to about 20% of the total for the entire United States. The number of passengers carried annually on the existing transportation lines in the city is some 60% more than the number carried by all the steam railways of the country.

Electrical Engineer—The Electrical Engineer, Clifton W. Wilder, maintains a bureau, not shown on the organization chart, employing about 60 engineering assistants. His work is divided into four main divisions as follows: (1) Passing on all plans for the electrical equipment; (2) cost accounting of equipment; (3) supervision of operation of the existing lines; (4) valuation of public-utility corporation properties. On the first two divisions, as a part of the new subway construction, he reports to the Chief Engineer, but on the supervision of operation and valuation work he reports directly to the Public Service Commission as its Electrical Engineer. He has one Principal Assistant Engineer and six Assistant Engineers. The supervision of operation includes such work as investigating complaints of equipment, accidents, regular inspection of equipment, special investigations, etc.

Personnel

The scheme of an engineering organization plays only a small part in its successful operation. Much depends on the men who are at the head of it. The Chief Engineer of the Public Service Commission is himself the kind of man to appreciate the importance of personality in the efficient working of the splendid organization he has achieved; and he not only takes a kindly interest in his many subordinates and makes himself accessible to them, but has so designed the working of the entire organization as to promote individual effort, enthusiasm and loyalty.

Alfred Craven

The Chief Engineer of this great organization, which at present includes approximately 1000 engineering employees—and it is growing—is a descendant of a distinguished family of naval officers and engineers. He was the son of Rear-Admiral Thomas T. Craven, who served throughout the Civil War and was afterward Commandant of the Mare Island Navy Yard. He is a nephew of Alfred W. Craven, Chief Engineer of the old Croton Aqueduct, builder of much of the original sewer system of lower Manhattan, the Central Park Reservoir, and many other historic engineering works in and about New York City.

Alfred Craven was born at Bound Brook, N. J., Sept. 16, 1846. At 17 years of age, at the height of the Civil War period, he was appointed to the United States Naval Academy, then conducted at Newport, R. I. Later, after the coming of peace, the Academy returned to Annapolis, Md., where Mr. Craven was graduated in 1867. After a few years' service, and while on the Pacific Coast, he retired from the Navy with the rank of Master, to devote his life to engineering.

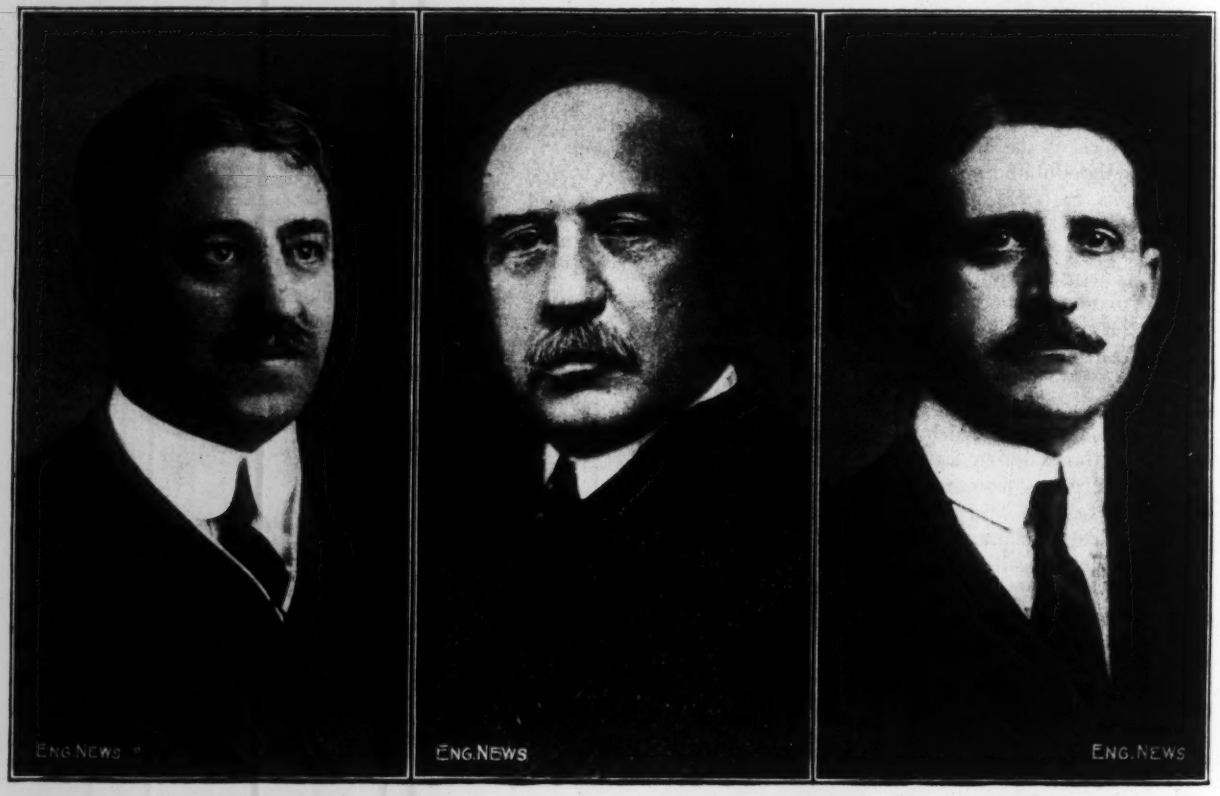
In 1871, he joined the California Geological Survey. Later, he was engaged in irrigation work in the Sacramento and San Joaquin Valleys, and then began private practice in Virginia City, where he established a reputation as a mining engineer in connection with the development of the famous Comstock lode. On this work he was associated with Adolph Sutro in the construction of the well known Sutro tunnel.

Mr. Craven returned East in 1884 to become Division Engineer of the new Croton Aqueduct for the additional

water supply for the City of New York, where he was in charge of a construction division and later of the Carmel and Titicus dams and reservoirs. On this work he established an enviable reputation for rugged honesty in the midst of graft and corruption on the part of contractors and politicians. After some straightforward and unimpeachable testimony before a legislative committee, an incensed politician is said to have told Mr. Craven, "You've done the last stroke of work you ever will do on this job." Whereat, Mr. Craven is said to have quietly replied, "I'll be here when you're all gone"—which proved correct, for the Aqueduct Commission was subsequently reorganized by Mayor Hewitt, and men of a

St. and Park Ave. through Forty-second St. and up Broadway to 104th St., the section through Forty-second St. and under the Times Building being one of the most difficult and delicate pieces of the whole work. He succeeded George S. Rice as Deputy Chief Engineer of the Rapid Transit Commission in 1904, when Mr. Rice became Chief Engineer, and succeeded to the office of Deputy Engineer of Subway Construction under Mr. Rice, when the Public Service Commission was organized in 1907. In 1910, Mr. Craven succeeded H. B. Seaman as Chief Engineer of the Commission.

Mr. Craven has not only distinguished himself in his 44 years of varied experience as a great engineer and



Chief Engineer (center), Engineer of Subway Construction (right), Deputy Engineer Subway Construction (left), of the Public Service Commisison, First District, New York.

caliber to appreciate honest service were appointed.

For eleven years, Mr. Craven was Division Engineer on the Croton Aqueduct and Reservoirs, and then in 1895, he was placed in charge of the construction of the Jerome Park Reservoir. Following a change in the Engineering Staff of the Commission, the plans of the work were altered in such a way which did not meet with Mr. Craven's approval and early in 1900 he was transferred to another division of the work. For what happened afterwards at Jerome Park, he is in no way responsible.

In May, 1900, when the first New York City subways were begun, Mr. Craven joined the engineering staff of the Rapid Transit Commission as Division Engineer, in charge of construction of the division from Forty-first

executive, but has gained a reputation as an arbitor and peacemaker in solving the intricate problems in relation to the control and operation of the dual transit system now under construction. For days at a time he has appeared as a witness at the hearings of the Commission and of the courts and has won the respect of lawyers, capitalists, railway-operating officers, and commissioners, not only by the breadth and accuracy of his technical knowledge, but by the clearness and force with which he presented it.

Robert Ridgway

Mr. Craven's first lieutenant, Robert Ridgway, was born in Brooklyn, N. Y., Oct. 19, 1862. He lived in

Brooklyn and on a New Jersey farm until he was 19 years of age. He never attended a college or technical school.

In May, 1882, he went West and joined the engineer corps of the Northern Pacific Ry., serving as chainman, rodman and leveler on preliminary surveys in Montana, and on location and construction in Wisconsin. Mr. Ridgway returned to the East in the summer of 1884 to accept a position as a leveler with the Croton Aqueduct Commission, New York City.

For 16 years he was a member of the Commission's engineering staff. His first important assignment was as Assistant Engineer in charge of the construction of the gate-house and appurtenances at the Croton dam and the northerly 1½ miles of the new Croton Aqueduct, from 1886 to 1890. On the practical completion of this work he was made Assistant Engineer of Construction of Reservoir M and appurtenances, on the Titicus River, which included the construction of a masonry dam having a maximum height of 130 ft., with earth wings 100 ft. in height. Subsequently, he was Assistant Engineer in charge of the construction of the Jerome Park reservoir, serving there under his present chief, Mr. Craven, who was Division Engineer.

He followed his chief to the Rapid Transit Commission in 1900 as his Senior Assistant Engineer on the Second division. In March, 1903, Mr. Ridgway was promoted to be Division Engineer and was placed in charge of the Fifth division, including the construction of the South Ferry loop, the tunnels under the East River from the Battery to Brooklyn and the Brooklyn subway.

When the Board of Water Supply was organized in 1905 for the construction of an additional system for the water-supply of New York City, he joined the staff of its Chief Engineer, J. Waldo Smith, as Division Engineer, and was promoted the following spring to the position of Department Engineer in charge of the Northern Aqueduct Department, which included the location and construction of the upper 60 miles of the Catskill Aqueduct. The Hudson River crossing at Storm King mountain was in his department. Here he continued until the practical completion of most of the work under construction, in January, 1912, when he was again called to serve under his former chief, Mr. Craven, with the Public Service Commission.

Daniel Lawrence Turner

Daniel Lawrence Turner was born in 1869. He graduated from Rensselaer Polytechnic Institute with the degree of C. E. in 1891.

For a year he was assistant in mathematics at the Institute, and then for three years he was Assistant Engineer in charge of the location and construction of a standard-gage switchback railway near Middletown, Conn., for the Columbia Granite Co.

In 1893, he was engaged in railway location work and as Engineer for Ernest Flagg, Architect, New York City. For nine years following, Mr. Turner was Instructor in surveying, railway engineering and hydraulics at Harvard University. While at Harvard he inaugurated the Harvard engineering camp and established and conducted for a number of years the present camp at Squam Lake, N. H. During this period, he was also engaged in private practice with special reference to hydraulic engineering.

Mr. Turner, like his chief and Mr. Ridgway, is also a pioneer New York City subway engineer. His experience in this work dates from the beginning of the subway work in 1900 when he became a member of the engineering staff of the Rapid Transit Commission. During the life of the Rapid Transit Commission 1900-1907, he served in various capacities, first on the preparation of drainage plans, as Assistant Engineer in charge of stations and in charge of surveys for subway extension to Brooklyn, including the East River triangulation. Later he was Division Engineer in charge of stations.

Upon the establishment of the Public Service Commission, First District, in 1907, Mr. Turner became Division Engineer of Stations and Chief of the Bureau of Transit Inspection, in which latter position he originated and formulated the methods of supervising the operation of the various street railways coming under the Public Service Commission's jurisdiction. For a year he was Division Engineer of the Seventh division of the new subways, and since 1912 he has been Deputy Engineer of Subway Construction.

Division Engineers

Sverre Dahm, Principal Assistant Engineer in charge of the Division of Design, was born in Norway, in 1858. His technical education was received at the Polytechnicum, Munich, Bavaria. He began his engineering experience as an Assistant Engineer on the Norwegian Government railways. His first work in America was as Assistant Engineer for Theodore Cooper, Consulting Engineer, New York City. Subsequently he was in bridge and structural work with the Long Island R.R., and with contractors in Chicago and New York City, until June, 1900, when he was appointed Assistant Engineer of the Rapid Transit Commission. Since then he has passed through various grades in the Rapid Transit Commission and its successor, the Public Service Commission, and since 1909, has been Principal Assistant Engineer.

Frederick W. Carpenter, Division Engineer of construction, was born in 1859, and graduated from Cornell University in 1884. For 10 years he was in railway construction and municipal work in the East and Middle West. In 1895 he was appointed Assistant Engineer, Bureau of Highways, Brooklyn, N. Y., where he remained until 1900, when he became Assistant Engineer of the Rapid Transit Commission. He continued as Assistant Engineer of the Public Service Commission, and in 1910 was promoted to be Senior Assistant Division Engineer, and Division Engineer in 1913.

John H. Myers, Division Engineer of construction, was born in 1869 and graduated from Rensselaer Polytechnic Institute in 1893. After a few years' experience in general surveying and engineering work in and about New York City, he spent six years as Assistant Engineer with the Department of Water Supply of Brooklyn, N. Y. In 1900 he joined the engineering staff of the Rapid Transit Commission as Assistant Engineer, and in 1906 he was promoted to be Division Engineer, which office he continued to hold under the Public Service Commission.

Frederick C. Noble, Division Engineer of construction, is a son of the late Alfred Noble. He was born in 1872 and graduated in civil engineering at the University of Michigan in 1894. Most of his experience until 1900 was in bridge and structural work. He

entered the service of the Rapid Transit Commission as a draftsman in June, 1900. He was promoted to be Assistant Engineer the following summer and to be Division Engineer in 1905. Mr. Noble has had immediate supervision of the design and preparation of contracts and specifications for the four East River tunnels for which contracts have recently been awarded.*

Cornelius V. V. Powers, Division Engineer of construction, was born in 1860. He is a graduate of the Columbia University School of Mines and his first experience was as Chemist and Metallurgist for a smelting company. His civil engineering experience began as a laborer with the New Croton Aqueduct Commission in 1885. He was successively promoted through subordinate positions to be Assistant Engineer. In 1900 he joined the staff of the Rapid Transit Commission as Assistant Engineer. He was promoted to be Division Engineer in 1903.

Jesse O. Shipman, Division Engineer of construction, was born in 1868. He graduated from Bucknell University, Pennsylvania, in 1890. The first 10 years of his engineering experience were spent mostly in railway survey and construction work. In June, 1900, he was appointed transitman with the Rapid Transit Commission and a year later Assistant Engineer. In April, 1910, he was promoted to be Senior Assistant Division Engineer and in October, 1911, Division Engineer.

Louis D. Fouquet, Division Engineer of Sewers, was born in 1867. He was in railway work in the East. From 1904 to 1908, he was Assistant Engineer of the New York, New Haven & Hartford R.R., and had charge of construction of two large Scherzer rolling lift draw bridges, one four-track and the other six-track. He joined the staff of the Public Service Commission in 1908 as Division Engineer.

The Division Engineer in charge of Subsurface Structures is C. N. Green, and George L. Lucas is Division Engineer in charge of Inspection of Materials and Construction.

Electrical Engineer

The Electrical Engineer of the Public Service Commission, Clifton W. Wilder, was born in Leominster, Mass., in 1876, and graduated from the Massachusetts Institute of Technology in 1898. For several years he was engaged in various kinds of electrical and mechanical engineering in and about Boston and New York City. He first became connected with New York City electric railway work in April 1905, as Assistant Engineer of Construction with the New York City Interborough Railway Co. He joined the staff of the Public Service Commission in November, 1907, as Assistant Electrical Engineer, becoming the head of the department in 1909. This position requires not only wide technical knowledge and experience in electrical engineering, but also the ability to appear as an advocate and expert at public hearings of the Commission.

*Mr. Noble resigned as Division Engineer of the Public Service Commission, as noted in our Personal columns of Sept. 17, to take up the consulting work of his father, the late Alfred Noble.

Train-Stops On the Chicago & Eastern Illinois R.R.

While automatic train stops as auxiliary to block signals are in extensive use on electric, elevated and underground railways, we believe the Chicago & Eastern Illinois R.R. is the only surface steam railway in this country which has a train-stop system in regular use. The system is the invention of H. B. Miller, of Staunton, Va., and for information concerning its use we are indebted to L. C. Hartley, Chief Engineer of the Chicago & Eastern Illinois R.R.

The equipment is on a stretch of double-track line between Hoopeston and Danville, Ill., 24 miles, having 35 blocks (with automatic block signals), each block equipped with the track-contact device for the train stop. About 90 locomotives in passenger and freight service are equipped with the contact shoe and brake-control apparatus. The traffic is from 18 to 20 trains daily on each track, but not all the locomotives on these runs are equipped with the train-stop apparatus. It is expected to extend the equipment north from Hoopeston to Dolton, an additional 82 miles of double track. The apparatus has been installed also on 20 miles of double track between Findley and Arthur (10 miles of automatic block signals and 10 miles of manual block), but this is not yet in service.

The track contact is a T-bar 180 ft. long, placed outside of the track, 22 in. from the rail, as shown in Fig. 1. It has a maximum height of 5 in. above the rail, and the ends are inclined, the contact shoe on the engine engaging the contact bar or ramp at about 3 in. above the rail. The contact apparatus on the engine, shown in Fig. 2,

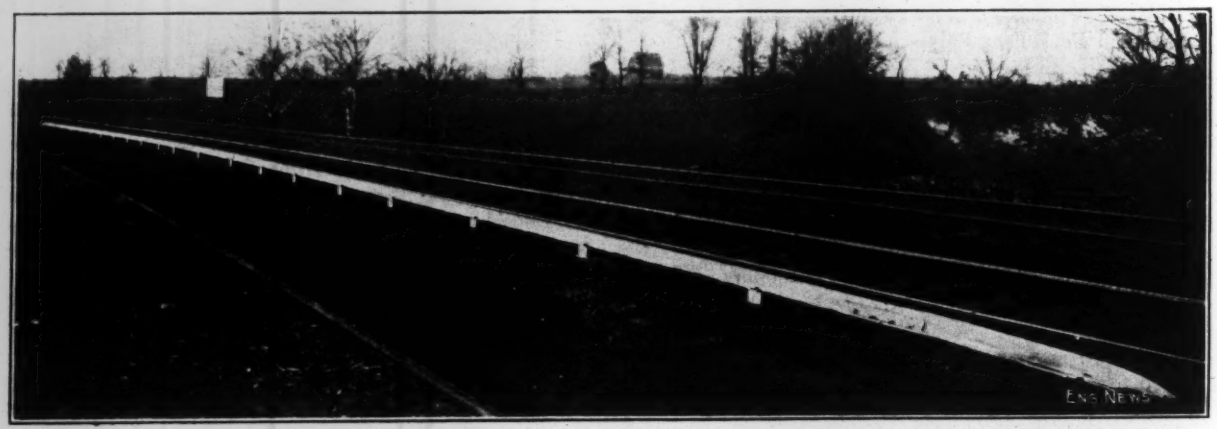


Fig. 1. Track Contact Device for the Miller Train-Stop System, Chicago & Eastern Illinois R.R.

consists of a shoe on a vertically sliding bar; this is raised when it engages the track device and its movement makes the necessary electrical connections to apply the air brakes and to close the throttle. The ramp or track contact is placed at such a distance from the signal as to enable a train to be stopped before reaching the signal; this distance varies with local conditions, but averages about 1500 ft.

The equipment was installed for a service test under regular traffic, and has been in use for about nine months. This included a part of the winter, but the apparatus worked successfully in spite of snow and sleet storms. We are informed that on different occasions its operation has stopped regular trains running at various speeds. As a matter of record of the test, each engineman (on the equipped engines) marks on a report card the position of each signal on the 24-mile stretch of track so governed.

The apparatus complies with the requirements of the American Railway Association, except that it will not correct the signal indication providing the track relay is held up, with block occupied. It is not equipped with the speed-control feature specified in the above requirements, but it is possible to add this when desired. There is no cab signal, either audible or visual, and no indication is given on the engine when passing a "clear" signal.

The following description is an abstract of an article in the *Signal Engineer*, by H. H. Orr, Chief Signal Inspector of the Chicago & Eastern Illinois Ry.

The train control is installed as an adjunct to the automatic block signals, and operated through the track relay and circuit controller. The first engines to be equipped were those used in the local freight service. It was thought that if there were any defects in the system they would develop on these runs, as here the most complicated conditions are met with. Many tests have been made on trains of various lengths with loaded and empty cars, and in each case the control has been effective in applying the air-brakes and closing the throttle simultaneously, making a smooth stop without unnecessary shock to the equipment of the engine or train.

The principle of the system is as follows: A stationary ramp, placed beside the track at braking distance back of each automatic signal (or the block station), is in the path of a contact shoe on the engine. This shoe, as it travels over the ramp, is raised vertically. If the block about to be entered is unoccupied and the signal ahead indicates "proceed," the vertical lift of the shoe does not affect the operation of the train. If the block ahead is occupied or the governing signal indicates "stop," this vertical lift of the shoe closes the throttle and applies the air-brakes, bringing the train to a stop.

The engine equipment consists of the control mechanism placed in a small steel box in the cab; the contact shoe, carried by a bracket on the crosshead guide, and air cylinders and connections for transmitting the motion of the shoe to the throttle and brake valve through the control mechanism. The track equipment consists of the ramp, a relay and battery located at the ramp, and a circuit controller at the signal ahead. The control mechanism is, in effect, a bell crank whose two arms are locked rigidly with respect to each other by the plunger of an electro-magnet normally deënergized. The upward motion of the shoe is transmitted to one arm of this crank through an air cylinder. The other arm of the crank is connected through an air cylinder to the throttle and brake valve. When the control magnet is energized, the crank arms are disengaged, thereby breaking the connection between the engine shoe and the brake valve.

Energy for operating the control magnet is supplied by a battery located at the ramp and so connected through the track relay and automatic signal that when the block about to be entered is unoccupied and the signal indicates "proceed," the battery is connected, one terminal to the facing end of the ramp and the other to the adjacent running rail. Under these conditions, the control will be energized the instant the engine shoe engages the ramp, and the train will pass over the ramp without interruption. When the block ahead is occupied or the governing signal indicates "stop," the battery is disconnected from the ramp; the control magnet of the engine passing over it will receive no current and the brakes will be applied and the throttle closed.

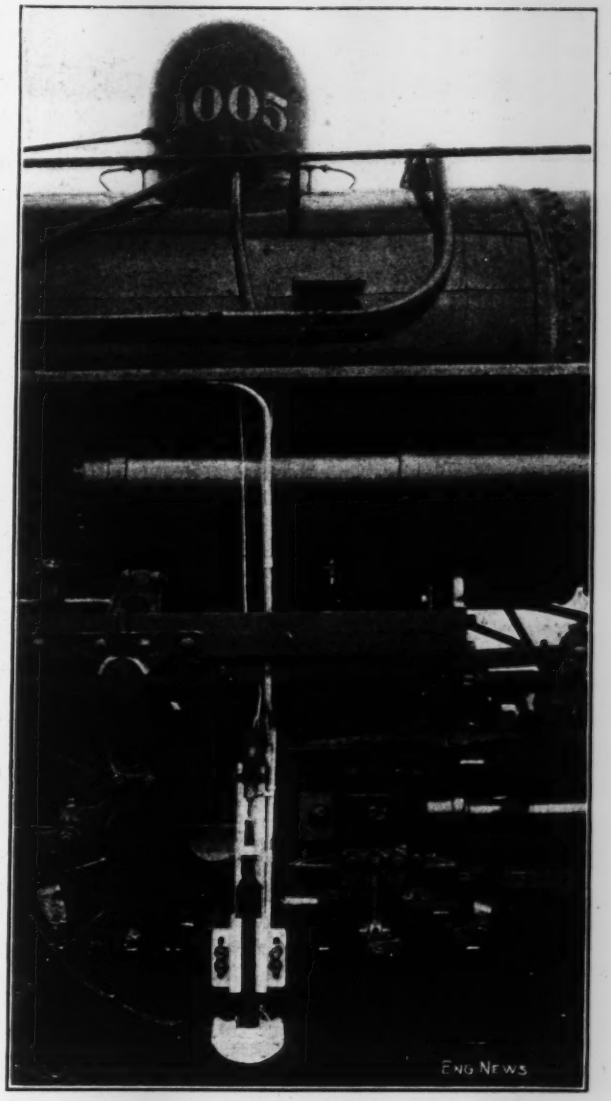


FIG. 2. CONTACT SHOE OF TRAIN-STOP SYSTEM ON A LOCOMOTIVE OF THE CHICAGO & EASTERN ILLINOIS R.R.

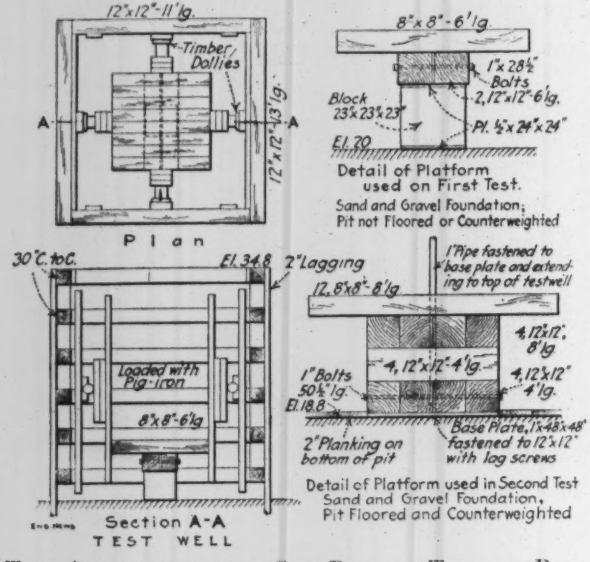
The ramp is divided by two insulated joints in the middle, the trailing end being supplied with energy for the purpose of energizing the control and preventing stop of an engine making a back-up move. As now applied, the breaks may be released and the throttle opened by the engineman in the usual way, at any time after being operated by the automatic-control system. This has proved satisfactory, but if thought desirable, a speedometer may be so locked as to necessitate the full stop of a train and release from the ground by the engineman. Due to the simplicity of the apparatus and its similarity to other signal and engine equipment, the maintenance can be cared for by the men employed in the maintenance of the signal and mechanical departments.

The records of this service show instances of "safety failure" or unnecessary stops due in general to such causes as commonly affect automatic signal operation, but in no case has the control failed to bring the train to a stop with the block ahead already occupied or the signal at "stop" position.

Field and Office

Soil-Bearing Tests for New Railroad Building, St. Paul, Minn.

Tests of material beneath ground filled in about 40 yr. ago in St. Paul were recently carried out to determine the feasibility of its holding up a new 12-story office building under a load of 4 tons per sq.ft. The structure is being erected on a 235x290-ft. space at Jackson and Sibley Sts. between Fourth and Fifth Sts., jointly by the Northern Pacific Ry. Co., the Great Northern Ry. and the First National Bank. Considerable doubt was felt as to the bearing value of the material under the filled area on the Fourth St. side, so that tests up to 8 tons per sq.ft. were initiated. The material under the footings, about 15 ft. below the surface, was a mixture of



TEST ARRANGEMENT FOR SOIL-BEARING TESTS AT RAILROAD BUILDING, ST. PAUL

coarse sand and comparatively small gravel with about 10% of clay. Possibly 5% of gravel would not pass a 1½-in. ring and the remainder was graded down to pea gravel.

Tests were carried out in a full-sized excavation down to the proposed bottom elevation of the footing, the pit being sheet-piled and braced.

FIRST TEST—The bottom of the pit was leveled and a block 24 in. square placed in the center with a 1-in. pipe extended to the top of the pit to provide a bench on which to take levels. Pig iron was loaded onto the 6x6-ft. platform. On account of the small size of the block a failure was reported on the test. The material was displaced and forced up outside of the base. The settlements are given in Table I.

SECOND TEST—A second test was then carried out with a block 4 ft. square, the remainder of the pit being covered with 2-in. planks counterweighted to 475 lb. per sq. ft. to meet as nearly as possible the actual conditions that would exist were the building completed. To obviate any danger of the pig iron shifting or tipping over, planks were placed on the four sides of the load and the timber dollies attached to the sides of the pit, leaving ⅛-in. clearance.

TABLE I. TEST WITH 2-FT. BLOCK; UNFLOORED PIT

Time, 1914	Load, tons per sq.ft.	Settlement, in.
May 21, 9 a. m.	No load	
May 22, 9 a. m.	4	¼
May 22, 3:30 p. m.	6½	1¼
May 23, 1:30 p. m.	6½	6½
	Total settlement	8¼

But ¼-in. total settlement was noted (Table II), which was considered due to the block reaching its proper bearing. Inspection of the material under the block after the test showed no indication of displacements. A ½-in. layer of cement which had been placed to level the block was cracked only in a few places.

TABLE II. TEST WITH 4-FT. BLOCK; PIT FLOORED AND COUNTERWEIGHTED

Time, 1914	Load, tons per sq.ft.	Settlement, in.
May 29, 2 p. m.	No load	0
May 30, 2 p. m.	1	¼
June 1, 7:30 a. m.	2	¼
June 2, 8:00 a. m.	4	0
June 3, 7:30 a. m.	4	0
June 4, 8:00 a. m.	6	0
June 5, 7:30 a. m.	6	0
June 6, 7:30 a. m.	8	0
	Total settlement,	¼

THIRD TEST—A test similar to the second one was repeated on the opposite side of the building site, where the material was all clean coarse sand. A total settlement of ½ in. occurred during the first part of the loading, the later readings up to 8 tons per sq.ft. showing no further settlement.

The tests were carried out under the direction of E. B. Morden, Superintendent of Construction. Grant Smith & Co. are contractors for the Railroad Building. Chas. A. Frost is the Architect.

Three Short-Cuts in Surveyors' Computations

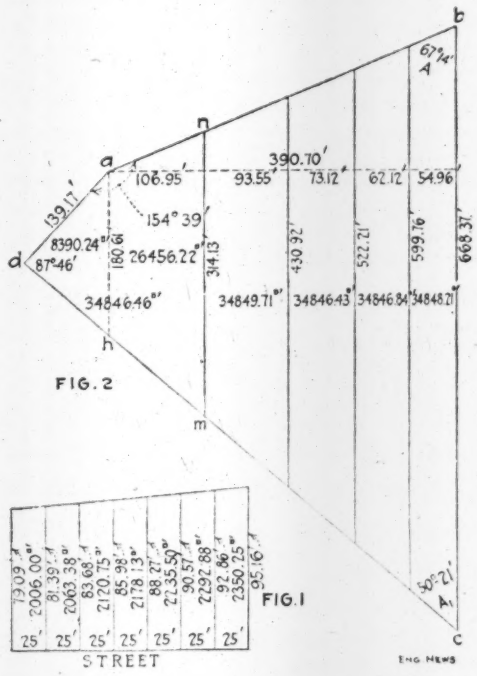
BY P. H. SKINNER*

1. In computations such as those affecting suburban property, where an error of 0.02 or 0.03 is in itself unobjectionable, this margin of accuracy may be commuted into time saved, by a very simple process.

A case that arises frequently is that shown in Fig. 1, where the rear line of a number of adjacent lots of equal frontage *a* makes an oblique angle *A* with the street. In this example the lengths of the first and last side lines are known or may be computed. The intermediate lot lines may be determined by adding *a tan A* successively to the smaller lot line, checking on the last lot line. But as *a tan A* can seldom be expressed exactly in hundredths, and as the lot lines are given to the nearest 0.01 ft., it fol-

*Chief Computer, Surveyor's Office, District of Columbia, Washington, D. C.

lows that there can be no common difference in length for all the lots, the difference between any two successive lot lines possibly varying by 0.01 from the difference immediately preceding or following. Hence it is necessary to compute the area of each lot separately, since an error of 0.01 in the length of the lot line makes an error of 0.005 a in area—a discrepancy easily detected, and giving an appearance of inaccuracy. If, however, the areas of the lots could be obtained by adding a common difference, checking exactly with lot lengths also obtained by adding a common difference, much time could be saved. This may be accomplished as follows:



Dividing the difference between the two outer lot lines, in this case 16.08, by the number of equal lots, 7, and carrying the result out to the nearest 0.005, we obtain 2.295, which we multiply by the number of lots, 7, giving 16.065, which we express to the next higher 0.01, giving 16.07. This we add to the smaller lot line, 79.09, giving 95.16. *The larger lot line is changed,* then, from 95.17 to 95.16, and the common difference for the lot lengths is 2.295, which we add successively to the smaller lot line, expressing the result always to the nearest higher hundredth.

When the above procedure calls for a difference of 0.02 between adopted length and actual length of the last side line, we may reduce one of the outer lines by 0.01 and increase the other by 0.01; that is, the change is to be divided as nearly equally as possible between the two outer lines.

The common difference of the areas is evidently the common difference of the lot lines, 2.295, multiplied by the lot width, 25, or 57.375. This difference we add successively to the area of the smaller lot, 2006, checking on the area of the larger lot, 2350.25.

Equal Lots in an Irregular Tract

2. A computation that sometimes arises for which a simple formula is desirable, is that shown in Fig. 2—where a trapezium or other irregular rectilinear figure is to be divided into a given number of lots of equal area by lines of a given direction. The first step is, of course, to determine the area of the entire figure $abcd$ = 174,240, which we divide by the number of lots required, 5, giving 34,848 as the common area of the resulting lots. Where the direction of the required lot lines is not parallel to an exterior line of the figure ad, the next step is to drop a line ah, of the required direction, to intersect cd, and determine the area of the figure adh, 8390.24, which we subtract from the common area 34,848, giving 26,457.76 as the area of the trapezoid $ahmn$.

To determine the width of $ahmn$, we have the formula

$$mn = \sqrt{(ah)^2 \pm 2F(\cot A \pm \cot A_1)}$$

where F = the area required, 26,457.76. Care must be taken to use the correct algebraic signs: if the angles A and A_1 are in the same quadrant we take the sum of $\cot A$ and $\cot A_1$; if in different quadrants, we take their difference; and the term containing this sum or difference is added to $(ah)^2$ when the lines bc and cd diverge toward mn, that is, when $A + A_1$ is less than 180°, and subtracted when greater.

Having obtained the length mn, we may either divide $mn - ah$ by $\cot A \pm \cot A_1$ to determine the width of the trapezoid, or we divide the area 26,457.76, by ½ $(ah + mn)$. The latter gives a greater degree of accuracy. As the lot depths are given only to the nearest hundredth, the areas computed from these depths will not quite tally with the required areas.

To obtain the lengths of the following lot lines, we add successively to $(mn)^2$, or 98,680.77, the amount $2F(\cot A \pm \cot A_1)$, or 87,009.88, giving 185,690.65, 272,700.53, etc. The square roots of these sums are the lengths of the lot lines required. The widths may be obtained by either of the methods described above. We may check the work by adding the width of each lot multiplied by $(\cot A \pm \cot A_1)$ successively to mn.

Saving a Line in Solving Triangles

3. Where a large number of right triangles is to be worked out by logs, as for instance in obtaining the coordinates for a traverse, we may effect a noticeable saving of time by writing the log of the course between log sin bearing and log cos bearing, posting the sum of log course and log sin bearing above, and the sum of the log course and log cos bearing below, thus:

(1)	log	242.51		= 2.3847387
(2)		sin	22° 19′ 30″	= 9.5796234
(3)		638.43		= 2.8051133
(4)		cos		= 9.9661624
(5)		590.58		= 2.7712757

Here line (1) is the sum of (2) and (3), and (5) is the sum of (3) and (4). Only five lines are written, as against the usual six, a saving of one line in six, or nearly 17% of the work of writing the quantities.

Similarly, where an oblique triangle is to be solved by the sine formula, we may write the work thus:

(1)	log	a		= 255.04	= 2.4066082
(2)		sin	A	= 42° 11′	= 9.8270493
(3)		c		= 379.18	= 2.5788454
(4)	colog	sin	C	= 93° 17′	= 0.0007135
(5)		sin	B	= 44° 32′	= 9.8459188
(6)		b		= 266.37	= 2.4254777

Line (1) is the sum of (2), (3) and (4), and (6) is the sum of (3), (4) and (5); six lines are written, against the usual seven. With a little practice this may be done mechanically, with no increased chance of error, and without effort.

Converting a Pin-Connected Bridge into a Riveted Structure

The conversion of a pin-connected bridge span into a riveted span is an interesting and very exceptional piece of bridge work recently carried out. The bridge is a single-track swing span on a branch of the Pennsylvania Lines, crossing the Grand Calumet River, at Burnham, Ill., and was built by A. Gottlieb & Co., in 1886. It is 183 ft. long, c. to c., having two 81-ft. arms and a central 21-ft. panel. It was necessary to adapt the bridge to carry heavy loading (Cooper's E-60), and investigation showed that this could be done much more rapidly and at much less cost by strengthening the old structure than by replacing it by a new bridge.

Figs. 1 and 2 show the original design and the alterations, and Fig. 3 shows some details of the resulting riveted trusses. The work in general was as follows: (1) Reinforcing the main trusses; (2) adding an additional row of stringers for each rail; (3) placing new top and bottom cover plates and additional end

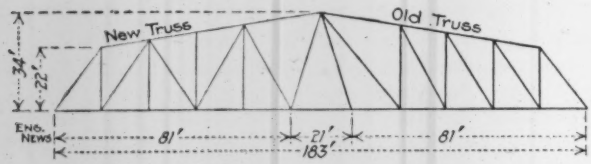


FIG. 1. DIAGRAM SHOWING DRAWBRIDGE WITH TRUSSES OF ORIGINAL PIN-CONNECTED TYPE AND AS ALTERED TO RIVETED TYPE

hanger plates on the floor-beams; (4) strengthening the circular girder of the turntable drum.

TRUSSES

The work on the trusses comprised the following changes (see Fig. 1): (1) Replacing posts *B-b, C-c* and *E-e* by new members. (2) Replacing the stiff web member *b-C* and *c-D* by new stiff members *b-C* and *C-d;* (3) replacing tension web members *d-E* and *e-F* by new stiff members *d-E* and *E-f;* (4) cutting the battens and lacing bars from the channels forming post *D-d,* shifting the channels inward (to clear the new gusset plates) and applying new battens and lacing bars; (5) applying new top cover plate and two new bottom flange angles to the end posts *a-B.* The old web members *c-D* and *e-F* are eliminated, and *f-F* has new battens at the bottom while the flanges of its channels are trimmed to clear the gusset plates.

In the bottom chord, gusset plates were applied for new riveted connections to the end posts and web members, new holes being drilled as required and battens removed where necessary to clear the gusset plates. The gusset plates at *d* were trimmed to clear the pin plates, and those at *f* were trimmed to clear rivets. In the top chord, similar work was done. The composition of the members is shown in the accompanying table.

MAKE-UP OF TRUSS MEMBERS OF BRIDGE CONVERTED FROM PIN-CONNECTED TO RIVETED; PENNSYLVANIA LINES.

Member	Original	Altered
Bottom chord, a to e	2 channels, 10⅝ in., 60 lb.	
" e to f	2 channels, 10⅝ in., 106 lb. 2 plates, 9x 7/16 in.	
" f to f'	2 channels, 10⅝ in., 106 lb.	
Top chord, B to F.	2 channels, 10⅝ in., 60 lb.	
Vertical, B-b	2 channels, 8 in., 43 lb., (removed)	4 L's, 6x3½x½in.
" C-c	2 channels, 7 in., 30 lb. (removed)	4 L's, 6x3½x½ in.
" D-d	2 channels, 9 in., 50 lb. (revised)	Channels moved closer.
" E-e	2 channels, 10½-in., 66 lb. (removed)	4 lbs., 6x3½x½ in.
End Post, a-B	2 channels, 10⅝ in., 73 lb.	1 plate 13x½ in. 2 L's, 3½x3½x½ in.
Diagonal, b-C	2 channels, 7 in., 30 lb. (removed)	4 L's, 3½x3½x½ in. 2 plates, 10 x½ in.
" C-d	(In place of c-D removed)	4 L's, 3½x3½x½ in. 2 plates, 14x½ in.
" d-E	2 eyebars, 5x1½ in., removed	4 L's, 3½x3½x 7/16 in. 2 plates, 14x½ in.
" E-f	(In place of e-F removed)	4 L's, 3½x3½x½ in. 2 plates 16x½ in.
" f-F	2 channels, 12¼ in., 112 lb.	Flanges trimmed, new battens.

ERECTION WORK

Under the railway company's instructions, the first work was confined to the half of the bridge west of the pivot, and this was completed before beginning work on the other half of the bridge. The blocking and shoring used are shown in Fig. 2.

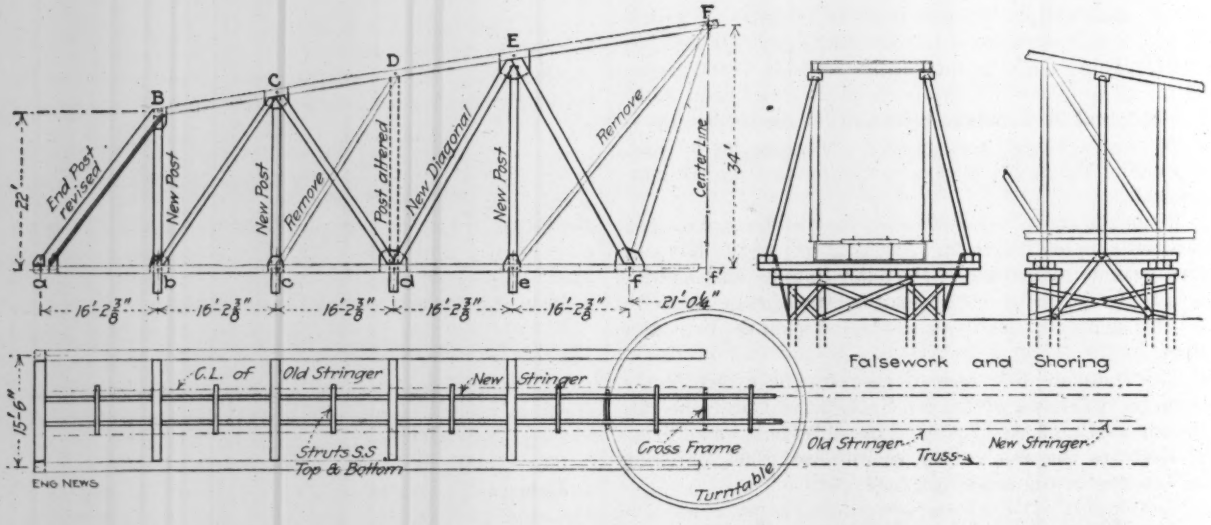


FIG. 2. DRAWBRIDGE OVER THE GRAND CALUMET RIVER AT CHICAGO, PENNSYLVANIA LINES; ORIGINALLY WITH PIN-CONNECTED TRUSSES, NOW CONVERTED TO RIVETED TRUSSES

(The heavy lines show the new work.)

It was required that all floor-beams must have full bearing on the pile bents before any truss members were disturbed. For the half of the bridge on which work was done the top-chord members of both trusses were supported at the center of each panel by shoring timbers, as shown. And in the other half of the bridge, opposite that which was being prepared for reinforcement, the member *d-E* was stiffened by fitting a 6x12-in. timber (in one piece) between the eye-bars, and fastening it to these bars, its ends bearing against oak blocks fitted and secured at the top and bottom panel points.

The bridge being thus supported on falsework, all members to be removed were cut away; this included the batten plates and lacing bars on *d-D*, the pins, floor-beam hangers, etc., except that the temporary removal of battens and lacing bars on *f-F* was deferred until it became necessary. In the top and bottom chords, the batten plates and lacing bars were cut away where necessary to admit of placing the new truss members. No drilling of holes between the gusset plates and the webs of top or bottom chords was permitted until all new members were assembled and field-bolted in position.

The placing of new members was specified to be done in the following order: Diagonal *E-f* must be swung over the old member *f-F* in such a manner that the gusset plates at *E* could be put in position, and also so that the post *e-E* might be placed in approximate position, but with its upper part against the diagonal *E-f*, so as to permit of swinging the diagonal *d-E* in place after the gusset plates at *d* were in position. Then the post *e-E* was set, followed in the order named by the gussets *f*, diagonal *E-f*, gussets *C*, diagonal *C-d*, post *C-c*, gussets *b*, and diagonal *b-C*.

Then the new floor-beam pin plates were placed in position at points *c*, *d* and *e*, and the pins at these points were replaced. The work on the end post was allowed to be done at any convenient time, except that the reinforcement of its bottom flange was required to be riveted up completely before placing the post *b-B* in position. This post being placed in position temporarily, all members were then bolted together and holes drilled through the webs of the top and bottom chords to correspond with the holes in the gusset plates, using templates on the outside of the chords. In riveting diagonal *b-C* to the gussets at *b*, the post *b-B* had to be swung clear at the bottom, after which the post was replaced in position, with the hanger *FB*-1 and the pin replaced at *b*.

The final riveting of the new members in place was then proceeded with. It was necessary to draw the channels of old member *d-D* first to one side and then to the other in order to allow of driving rivets through the diagonal and gusset plates at *d*. The same had to be done with old member *f-F* for the riveting at *f*, but with special care, as this member might take stress when trains were crossing the bridge. Care had to be used in making the splice near the end of the bottom chord, so as to obtain the proper panel length, as shown on the drawings.

Other Work

Stringers—For placing the additional line of stringers under each rail, holes were drilled in the floor-beams for the end connections, using the filler plates as templates. Holes were cut in the webs for the bottom lateral rods, these rods being removed and replaced by passing them through the stringers. Before riveting the new stringers in place, all the filler plates, diaphragms, cross-frames, struts and lateral rods were fitted into place.

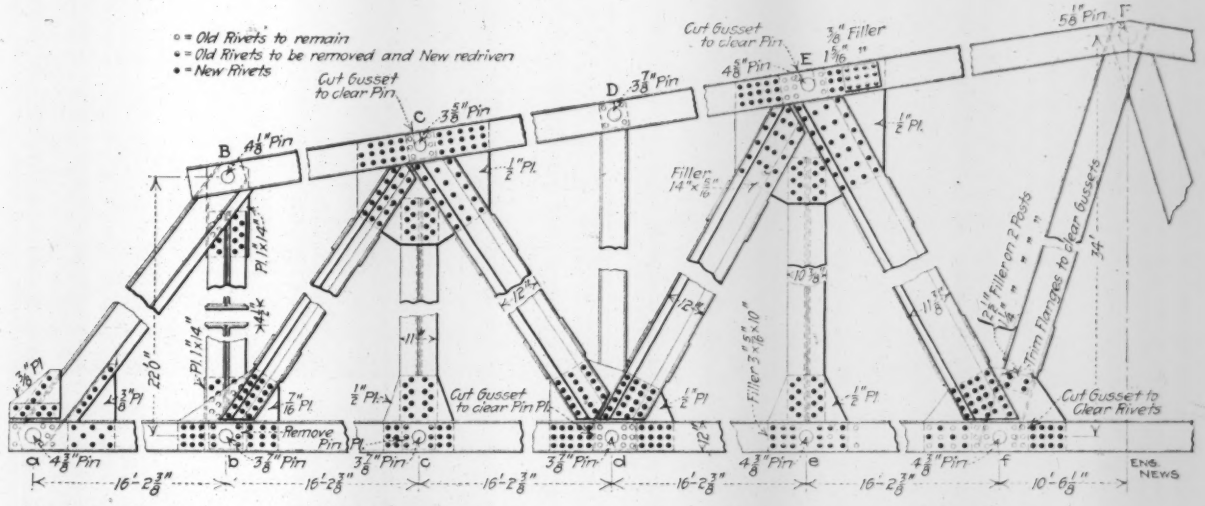

o = Old Rivets to remain
• = Old Rivets to be removed and New redriven
• = New Rivets
Cut Gusset to clear Pin
Cut Gusset to clear Pin
3/8" Filler
Filler 14" x 5/16"
Filler 2 x 5" x 5/16 x 10"
1" Filler on 2 Posts
Trim Flanges to clear Gussets
Remove Pin
Cut Gusset to clear Pin
Cut Gusset to Clear Rivets
ENG. NEWS

Fig. 3. Details of Truss as Converted from Pin-Connected to Riveted Truss

Floor-Beams—The new cover plates had ¾-in. punched holes reamed to $\frac{5}{16}$ in., and these plates were used as templates for drilling the old flange angles (in place). Before riveting up these plates all parts were adjusted to position; these included the stringers, operating-rod castings on intermediate floor-beams, rail-joint castings, diaphragms, and the stiffener angles on the end floor-beams.

The new hanger plates on the ends of the floor-beams being set in place, the old ones were replaced outside of them. The two plates were fastened together by the top five rivets (with flattened heads) before being put in final position. The new plates had been punched with ⅞-in. rivet holes and bored to fit the pins. The holes in the new and old plates and end angles were reamed to $1\frac{1}{16}$ in. in the field, for new 1-in. rivets. The truss pins were removed and replaced as part of the operation.

Drum Girder—The new top and bottom cover plates were added in the same way as described for the floor-

beams. New inclined stiffeners were run from the stringers to the center support.

CLEANING AND PAINTING—Where the old metal would be made inaccessible by the application of the new parts, the old surface was cleaned and given a coat of paint. All new metal was given a shop coat, and its contact surfaces were given an additional coat before assembling. After the completion of the work, all the metal was cleaned and given two coats of paint.

EXECUTION OF WORK—One arm of the bridge is over shallow water and the other over the navigable channel. The plan of reconstruction adopted was to build falsework under the former arm and make all the alterations to it, such truss pins being removed from it as were necessary to make way for the new parts. The bridge was then revolved, and the other arm treated in the same way. This falsework (which was built by the contractors) is shown in Fig. 2. The traffic averaged 20 trains daily.

As the work was done before the navigation season opened, the bridge was not required to be swung for river traffic. When reversed for the reconstruction work, it was swung by means of its hand-operated machinery in the regular manner. A locomotive crane standing on the bridge was used to take out the old members and put the new members in place, while the use of oxyacetylene torches in cutting away old material considerably reduced the time and cost of the work.

In all, about 20 tons of metal were removed and 80 tons of new metal placed, the bridge as now completed having a weight of about 170 tons.

The necessary alterations to the bridge and the methods of carrying them out were planned under the direction of J. C. Bland, Engineer of Bridges of the Pennsylvania Lines. The contract for the execution of the work was awarded Dec. 2, 1913, to the Great Lakes Dredge & Dock Co., of Chicago. This company also furnished detail and shop drawings for the approval of the railway engineers. Work was commenced Jan. 20, 1914, and completed May 13, 1914. The cost was approximately $16,500, while it is estimated that a new bridge to meet the same conditions would have cost about $75,000.

It is of interest to note that the Pennsylvania Lines strengthened the draw span over the Maumee River, at Toledo, in a similar fashion in 1908, this being a span 197 ft. 9 in. long. Not long after the work was completed, the bridge was considerably damaged by a collision from a boat, but had the original pin-connected structure still been in place, no doubt it would have been damaged much more seriously. The bridge was then repaired and carried traffic in good shape until recently when it was taken out of service.

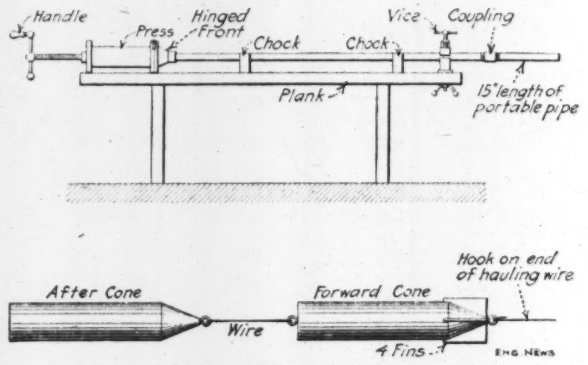
⌘

Form-Spacer Bolt with Adjustable Head—In the use of long bolts for form work, one of the disadvantages has been that one length of bolt was practicable for one thickness of wall only. General practice has been usually to buy bolts in over lengths, and for shorter work wooden blocks or spacers of some kind would be used to make the working length of the bolt shorter. Rather an interesting development to meet this problem is the use of a bolt with an adjustable head. This head is really a set-collar, with cup-point setscrew. The hole for the bolt is oval, and has two transverse ribs on the side opposite the setscrew, which help in clamping the bolt firm. Only one end of the bolt has this adjustable head; the opposite end has thread and nut like any other bolt, so that tightening up this bolt is in no way a special procedure. The Universal Stamping Co., Strasburg, Lancaster County, Penn., is putting this bolt on the market.

Lining Pipe with Cement

Cement-lined wrought-iron service pipes, because of their freedom from interior corrosion and stoppage, have been used in New England and probably to a lesser extent elsewhere for many years. As a rule, it appears that each water-works department lines its own pipe. Recently, a company has been organized in Boston* to line pipe on order, either taking pipe supplied to it or furnishing the pipe itself. The procedure in lining the pipe is as follows:

A screw-piston press 5 in. in diameter and about 18 in. long, mounted on one end of an 18-ft. plank, is used to force the mortar into the pipe. The forward head of the press cylinder is hinged to swing open; it has a central hole threaded for 2-in. pipe (other sizes are accommodated by use of bushings). The cylinder head is swung open, the cylinder filled with mortar, and the head closed and locked. The pipe to be lined is then screwed into the hole in the cylinder head. By forcing the piston ahead, the cement is then shoved out into the pipe. After this the pipe is unscrewed and moved ahead into a vise at the front end of the plank. A coupling is set up on the forward end, with a portable length of pipe about 15 in. long screwed into it as far as another pipe would be fitted, usually about six threads; this keeps the threads clear of mortar for connecting the length of pipe to another length.



APPARATUS FOR LINING WROUGHT-IRON OR STEEL PIPE WITH CEMENT MORTAR

A stiff wire is now pushed through the cement in the pipe, from the front end, and a pair of tapered mandrels is pulled through the pipe by means of this wire, to core out the bore of the pipe. The mandrels are short lengths of brass pipe with tapered front end, fastened together by a loose wire. The outside diameter of the mandrels is 1/4 in. less than the inside diameter of the pipe. The forward mandrel has four longitudinal fins, at 90-deg. intervals, to center it in the pipe, while the rear mandrel is smooth and, following through the bore made by the first mandrel, finishes it to shape and surface. The result is a smooth 1/8-in. lining of cement mortar. After inspection, the pipe is laid away for the mortar to harden. The short length of pipe at the point is unscrewed, but the coupling is left on.

All tees, elbows and other fittings are also lined with cement mortar, so applied as to give an interior surface continuous with that of the lined pipe and having minimum friction at the joints.

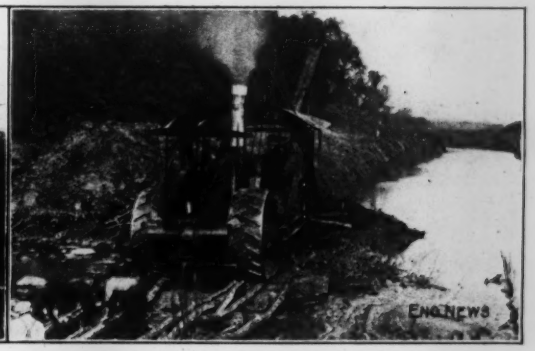
*Macbee Cement Lined Pipe Co., 228 Devonshire St., Boston, Mass.

Emergency Work in Drainage-Ditch Excavation

The contractor on the construction of the Storm Creek ditch in Carroll County, Iowa, met with the misfortune of losing his 3-yd. oil-power dredge by fire when the work was 93% completed, and had to find some way of doing the remaining work quickly and economically.

The contract amounted to 2,300,000 cu.yd., the main ditch being about 25 miles long. The laterals and all small work were completed, and when the large dredge was burned there was 8400 ft. of the main ditch to be dug, crossing the old channel at several points. This was a difficult proposition: The amount involved was only about $8500, and as the work was nine miles from a railway (at Glidden), it was a problem to get out a machine that could be handled within reasonable cost. It was estimated that to do the work by an ordinary large dredge would cost $20,000. Contractors owning dragline machines were invited to submit proposals but the conditions were too severe for them to bid. The contract prices on this part of the work were 5¼ and 7c. per yd., with no deductions made for the old channel. The specifications required a ditch of 35-ft. bottom width, 8 to 12 ft. deep, with 1 : 1 slopes.

A Combined Dragline Excavator and Oil-Engine Tractor for Ditch Work



Ditch Excavated by Oil-Engine Dragline Excavator

(The machine is shown crossing one of the numerous bends of the old channel intersected by the ditch.)

The features required in a machine to do the work within reasonable cost were quick delivery, low cost of transporting nine miles over land and installing on the work, low fuel consumption and small payroll expense. To meet the conditions, the contractor purchased a Turner dragline excavator, built by the United Iron Works Co., of Springfield, Mo. The machine was set up at the railway station, and traveled under its own power and on its own wheels to the work, making several turns at corners, and crossing two highway bridges. It required two days to move nine miles and cross the fields to the work. The machine has a steel frame, a 40-ft. boom and a 1½-yd. scraper bucket. It is driven by a 60-hp. oil tractor, the front wheels of the tractor being removed, and the front end of its frame resting on a cross-beam of the dragline machinery frame. The extending side beams connect to an extension hub that is bolted to the driving wheel of the tractor. These removable hubs and the addition of a spur wheel on the main engine shaft were the only changes made to the tractor. The power is conveyed from the engine shaft to pinion shaft of the dragline machinery through a sprocket chain. The machine can handle two scraper loads per minute.

On account of the wide ditch and amount of material to handle, the machine was operated double cutting, with material cast on both sides. Fig. 2 shows the machine finishing a cut, and shows the approximate width taken at each cut. It shows also the method of crossing the old channel, brush and logs being laid in the creek bed, with poles on top to form runways for the wheels.

The machine started June 27, 1914. The first 18 days' work cost for labor $322.62, including one extra man dynamiting a ditch through a short cut. Fuel cost, $3 per 10-hr. work, being for 60 gal. of distillate. The 18 days', or 360 hours', work amounted to 42,913 cu.yd.

A considerable amount of work on the old channel figured in this estimate, but the machine met the conditions of moving from one cut to another and maneuvering to handle the material and open up into the old channel; such items being delays against actual digging. Part of the work is through heavy timber, and the banks were generally high and entirely of earth, although at the lower end of the stream there was good gravel bottom. For the crossings, places were selected where the material could be handled to the best advantage, and in going from one cut to another the machine would travel out around the bends or be moved to a place where a crossing could be put in to get across the old channel. It has excavated as high as 100 cu.yd. per hour, but the average seems to be about 65 or 70 yd. as there was so much maneuvering at the end of the cuts where the machine came up against the old channel.

On the cut which the machine is shown finishing, in Fig. 2, the work included 15 hours making bridge and crossing it, 133 hours making the complete cut, 8772 cu. yd. actual cutting, or 66 cu.yd. per hr., no deductions made for time of turning machine and finishing cut at upstream end. The labor cost is 77c. per hour and fuel 30c. per hour.

Two men can operate the machine; three were used here because of the extra amount of labor necessary on the crossings. Two short cutoffs were handled by blasting a ditch through them and then damming the stream by using the machine to build an earth dam and turning the water through the blasted ditch.

The engineer in charge is I. W. Hoffmann, of Carroll, Iowa. The contractor is D. C. Stephens, of Buffalo, N. Y., the work being handled by his western office (815 Hippee Bldg., Des Moines, Iowa), of which H. B. Whitney is Manager. For information we are indebted to Mr. Whitney.

Cross-Section Measurements by a System of Polar Coordinates

By Edward F. Verplanck*

When steam-shovel excavation began on the Cape Cod Canal, direct tape measurements for obtaining the cross-sections of the cuts became greatly impeded. To facilitate the work, the writer developed a method of surveying in which the center line offset distances were obtained by trigonometric computation from observed angles, instead of by direct measurements.

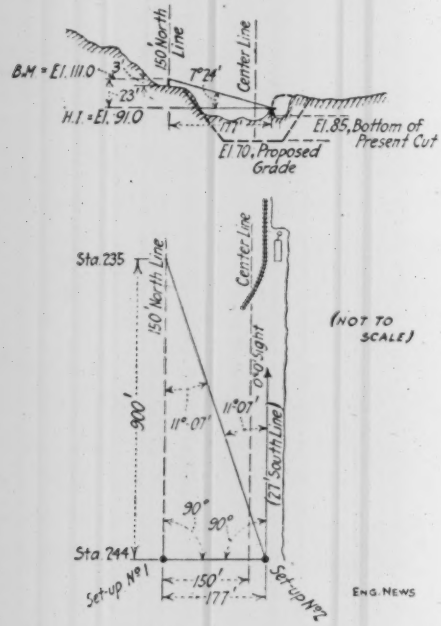


Fig. 1. Cross-Section Measurements, Cape Cod Canal

Field Operations—Referring to Fig. 1, the transit was set up on the permanent reference line 150 ft. north of the center line, and a point was established at random near the center line on the cross-section line. The transit was moved to this point and the offset distance from the center line determined by triangulation and the transit oriented so that all angles were afterward measured as though from a reference line through the transit parallel to the center line at this offset. The perpendicular distance of an observed point from this reference line was found by multiplying the distance from the station of the set-up to the station of the point, by the tangent of the deflection angle; and subtracting the offset from this gave the distance from the center line.

The H. I. was obtained by a trigonometric computation from the vertical angle measured to the benchmark, on the reference line. The elevations of the top of stake at every station on this line had been previously determined.

Cross-sections were obtained by angle and rod readings. The rodman ranged himself in on each section line by means of permanent range targets located outside the canal prism. Table I shows part of the field notes of this survey after having been completely worked up in the office.

*Engineer Cape Cod Construction Co., Sandwich, Mass.

TABLE I. SAMPLE FIELD NOTES.

Sta.	Inst. at	Sight	Rod reading	Angle	Base	Base × tangent	Offset from center line	Elev.
237	Sta =244+0	On 244, 150 Nor	5.4	0-50L	700	10N	17S	85.6
	Offset =27 Sou	=90°-0′ L	3.1	0-01L		0N	27S	87.9
	H. I. =91.0		3.3	1-30R		18S	45S	87.7
		Vert-ang.	6.7	1-48R		22S	49S	84.3
		=7°-24′	7.5	3-05R		38S	65S	83.5
		R. R.	6.2	4-50R		59S	86S	84.8
		=3.0	Top bank	5-10R		63S	90S	Previous surface

TABLE II. SAMPLE FIELD NOTES OF CURVED CENTER LINE.

Sta.	Backsight on internal radius with vernier at	Inst.	Rod Reading	Angle	Base	Base × tang.	0°-0′ point	From	Elev.
256	86°-0′R	Sta. =24S	4.1	1-01R	799	14S	Transit =10S	4N	86.9
		Offset =10S	6.2	1-15R		17S	Tan. offset	1N	84.8
		H. I. =91.0	7.3	2-15R		31S	8 sta. =2S.0	13S	83.7
			6.1	3-10R		44S	Reference	26S	84.9
			1.9	3-44R		52S	point =18N	34S	89.1
			1.6	4-31R		63S		45S	89.4

Curved Center Line—This method, with certain modifications, was applied with equal success to the 0° 30′ curves of the Cape Cod canal. Fig. 2 shows the layout of such a survey.

The transit was set up on the 150-ft. north reference line and a point established near the center line on the radial section line through the transit station, and the transit was set up over this point and oriented parallel to a tangent of the curve at the station of the cross-section to be taken. A study of Fig. 2 will show the angles necessary to be turned in order to get this orientation

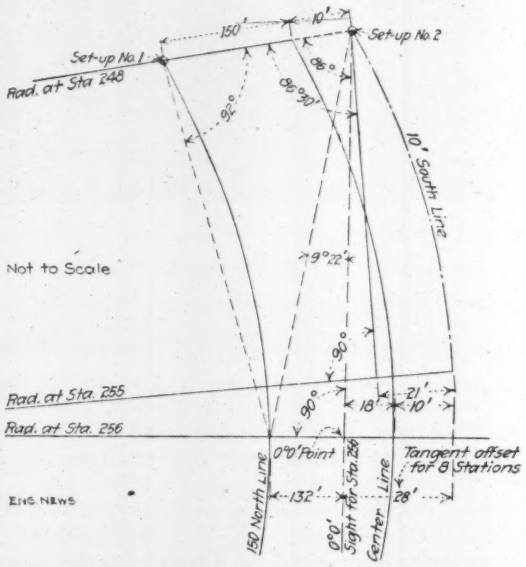


Fig. 2. Cross-Section Measurements on Curved Center Line

The perpendicular distance from the transit to the station of the observed point was obtained by multiplying the distance of the transit from the center of the curve by the sine of the central angle between the transit and the observed point. Then the offsets were found by multiplying the distance thus found by the tangent of the deflection angle from this perpendicular—the same method as before. The transit was set parallel to the desired tangent at successive stations by changing the setting 30′, or the central angle for a 30′ curve. Table II shows a part of the field notes for this survey with all office computations performed.

Conclusions—One of the great advantages of this

procedure, besides its extreme rapidity, was the fact that only two men were required to make the survey, a transitman (keeping his own notes) and a rodman. By the direct-tape-measurement method, three men are indispensable.

The work was done under the direction of C. T. Waring, Resident Engineer of the Cape Cod Construction Co., of Sandwich, Mass., of which Wm. Barclay Parsons, of New York City, is Chief Engineer.

Increasing the Height of a Chimney While in Service

An interesting piece of work carried out recently was that of increasing the height of a chimney by 30 ft., and doing this while the chimney was in use. This was at the plant of the Northwestern Malt & Grain Co., Kenton and Cortland Sts., Chicago.

The original stack was 129 ft. high, of square section, 6x6 ft. square inside at the top, and built of common sewer brick. It was desired to increase the height by 30 ft., and this extension is of circular section, 6 ft. diameter, built of radial brick. The top of the old stack (including its cap or cornice) was torn down for 6 ft., and replaced by a connection changing from square to octagonal, this part being built of sewer brick. Above this is the 30-ft. circular extension.

The work was done from an outside scaffold supported on triangular frames. The upper end of each vertical leg was fitted with a hook, engaging a steel cable drawn around the chimney and tightened by a turnbuckle. When the men had laid the brick as high as they could reach, another cable was placed around this new section, with a second set of frames, the lower scaffold and cable being later removed and shifted above the other. An L-shaped builders' derrick on the chimney carried the cable for hoisting men and material. To protect the men from the direct attack of smoke and gases a steel shield, nearly semi-circular in plan, was fitted inside the flue, extending several feet above the brickwork, but on very windy days the men did not work.

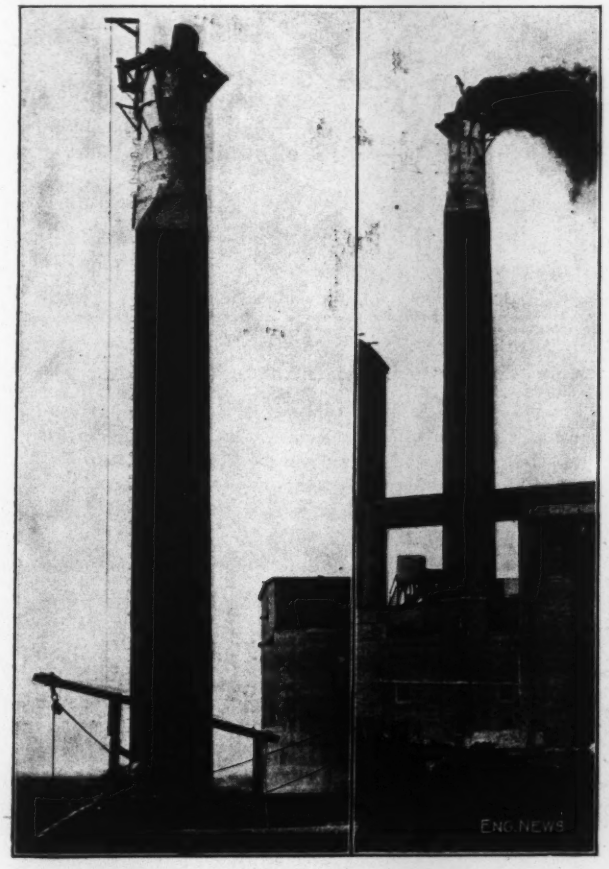


FIG. 1. BUILDING A 30-FT. EXTENSION TO A BRICK CHIMNEY

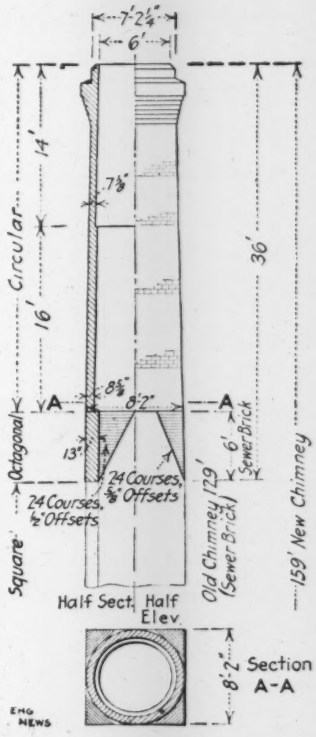


FIG. 2. A 30-FT. CIRCULAR EXTENSION ON A 129-FT. SQUARE BRICK CHIMNEY

Fig. 1 shows the work very clearly. In the left-hand view may be seen the working platform on its brackets, and two of the brackets at a low level still hooked to the cable around the chimney. At the top are seen the steel shield (at the right) and the hoisting derrick. The derrick near the bottom of the view is for repair work on an adjacent building. The right-hand view shows the entire chimney and shows it during heavy emission of smoke.

This work is being done by the Alphons Custodis Chimney Construction Co., of Chicago. This company has done similar work on a number of chimneys, the extension in one case having been 60 ft. high.

Impact Formula for City Street Bridges—In designing the Bloomfield cantilever bridge, Pittsburgh, Penn., which is just being completed, an impact formula was used, the live-load stresses being increased by a variable percentage to allow for vibration and other traffic effects. The formula used is:

$$I = S\frac{100}{L + 300}$$

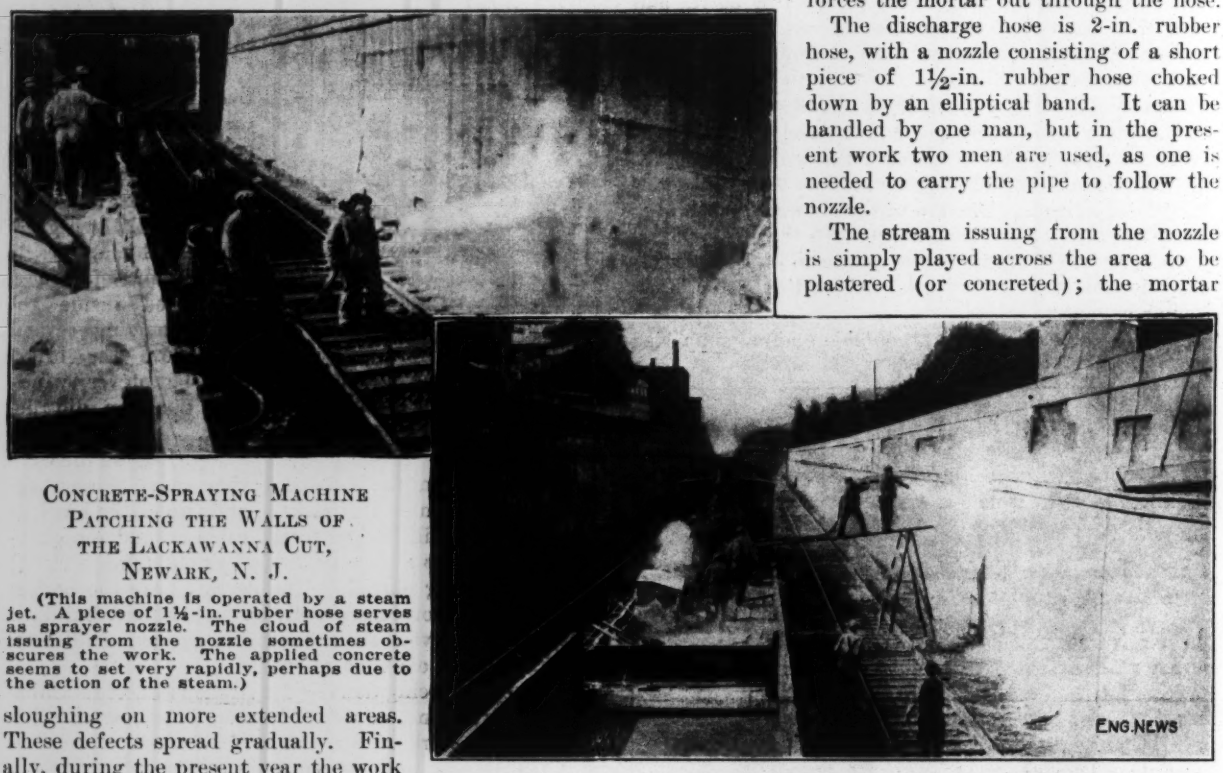
where I = impact addition, S = live-load stress, and L = loaded length of bridge in feet. The formula gives an impact addition one-third as great as that applied to railway bridges under a commonly used formula. T. J. Wilkerson is Engineer of Bridges of the City of Pittsburgh.

A Metallic Tape Detachable from the Reel Box by a new device called a "threader" has been patented and placed on the market by the Lufkin Rule Co., of Saginaw, Mich., and will hereafter be furnished with this company's "metallic" woven tapes without extra charge. The "threader" is a loop and stud arrangement, by means of which the tape is securely fastened to the winding drum of the reel, when the tape is in use, but which permits an old worn out tape to be readily detached and replaced by a new one. The life of the tape is generally much shorter than that of the leather case or reel box, so that the latter, which represents about half the first cost of the instrument, may be used as long as it is fit for service.

Patching Concrete Retaining-Walls by a Concrete-Spraying Machine

Extensive patching of surface defects on concrete retaining walls is being done by the Delaware, Lackawanna & Western Ry., at Newark, N. J., where its Morris & Essex division runs through a retained cut a mile long and up to 25 ft. deep. An interesting new concrete-spraying machine is used for the work.

The retaining walls were built about ten years ago. After a few years they began to show serious deterioration on the face—mainly horizontal cracking and spalling at the day's-work planes, but also superficial scaling or sloughing on more extended areas. These defects spread gradually. Finally, during the present year the work of patching the wall was started.



CONCRETE-SPRAYING MACHINE PATCHING THE WALLS OF THE LACKAWANNA CUT, NEWARK, N. J.

(This machine is operated by a steam jet. A piece of 1½-in. rubber hose serves as sprayer nozzle. The cloud of steam issuing from the nozzle sometimes obscures the work. The applied concrete seems to set very rapidly, perhaps due to the action of the steam.)

Before patching, the bad spots were cleaned out. The repair gang went through the cut and chiseled out the poor concrete at the points of deterioration, down to solid concrete, usually an inch or so, leaving the wall pretty thoroughly marked up with "holes" ranging in size up to two or three feet wide and up to six feet long, ready for plaster patching.

The first part of the patching, just west of Newark station, was done by hand troweling, using 1 : 3 cement mortar. Then a cement-spraying machine, called "Concrete Atomizer," was put on the job, and the rest of the work has been done with it.

THE MACHINE—The "Atomizer," of whose internal construction not much can be said as yet, consists of a closed cylindrical tank with central shaft carrying baffles or paddles and other mixing devices; and a discharge hose leading out of the tank. Mortar materials are fed into the front of the tank, the end opposite the hose outlet. The machine can be operated by steam or by compressed air. Its mechanical construction allows of using large-sized aggregate in the concrete.*

PLANT USED—In the Newark work steam at 65 lb. is used to run the "Atomizer," being more conveniently available than air. A switching locomotive furnishes the steam and at the same time hauls the work train, comprising the car carrying the machine and sand, and a caboose or tool car.

OPERATION—A batch for the machine consists of two pails cement and six pails sand. These materials and the required amount of water are charged in through the front door of the tank, and after closing the door are mixed by turning on steam, which revolves the paddles. Then the outlet valve is opened and the steam pressure forces the mortar out through the hose.

The discharge hose is 2-in. rubber hose, with a nozzle consisting of a short piece of 1½-in. rubber hose choked down by an elliptical band. It can be handled by one man, but in the present work two men are used, as one is needed to carry the pipe to follow the nozzle.

The stream issuing from the nozzle is simply played across the area to be plastered (or concreted); the mortar deposited on the wall is very dense and hardens rapidly (perhaps due to the accelerating effect of the steam). The stream of mortar is surrounded by a cloud of steam, so that the nozzle-man cannot always see the surface on which he is working. Little cement or sand drops out of the stream or off the work, however.

Trimming and screeding or smoothing is done by hand after the machine has placed the mortar.

The working force on the Lackawanna wall patching comprises: 2 men feeding, 1 man operating machine, 2 men at nozzle, 1 laborer, 3 or 4 cleaners smoothing up the patches, 1 foreman. The locomotive crew takes care of the steam control.

The "Concrete Atomizer" is controlled by Harold P. Brown, 122 Liberty St., New York, and was leased by him for the Lackawanna work, the railway company furnishing the labor.

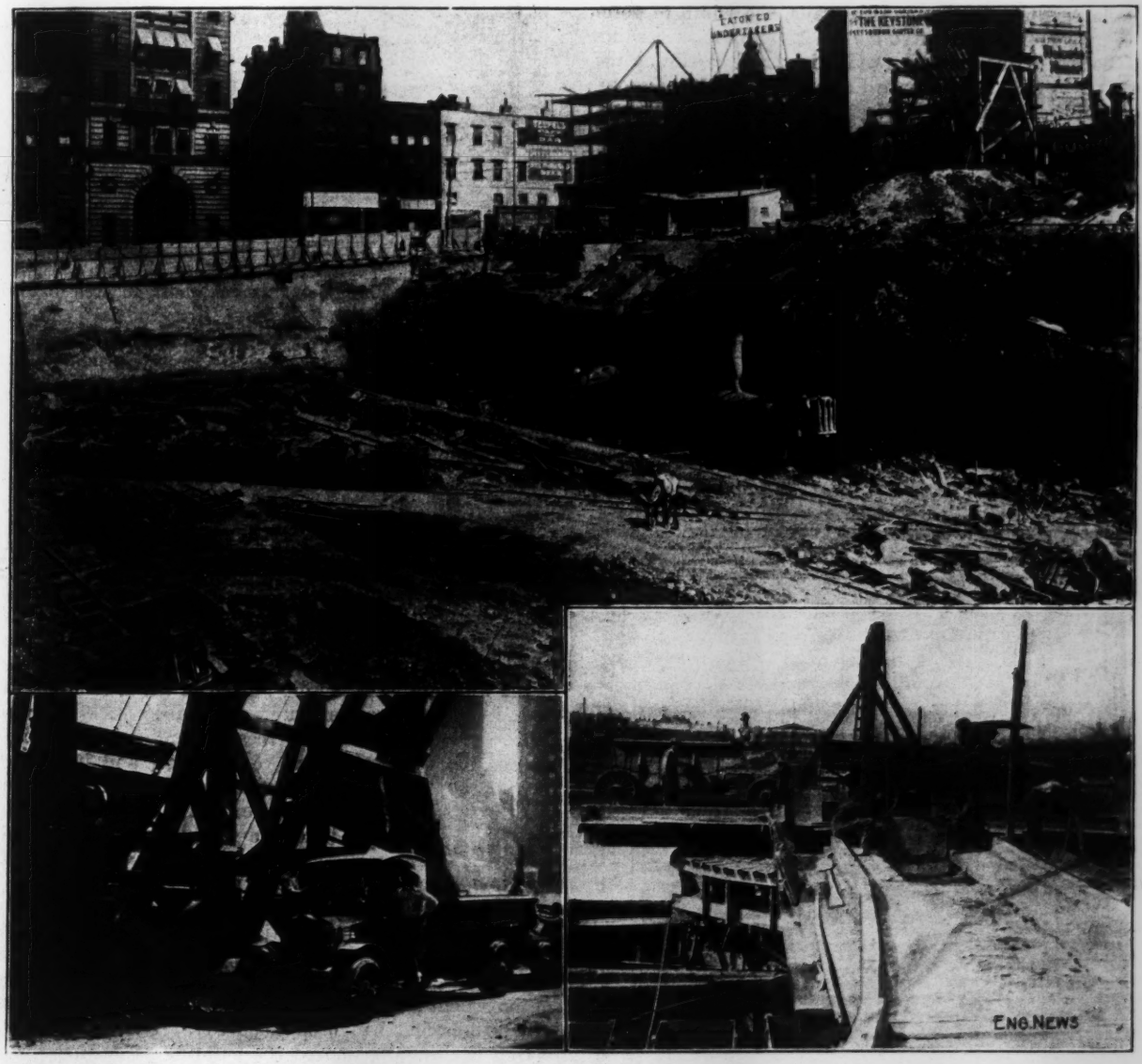
*Gravel concrete with gravel up to ¾-in. was handled by the machine in some prior work at the Lackawanna terminal station at Hoboken, in repairing concrete footing piers which seemed to have been affected by the action of the water. There the machine was operated by compressed air.

Handling Excavation for the William Penn Hotel, Pittsburgh

The large cellar excavation for the new 20-story William Penn Hotel, in Pittsburgh, Penn., called for exceptional methods for handling the dirt, if speed and low cost were to be secured. The contractor met this requirement by installing a highly organized mechanical equipment.

The site is at Sixth and Oliver Aves. and Cherry Way, and measures 216x130 ft.; the depth to be excavated ranges from 40 to 60 ft., with a volume of 50,000 to 60,000 cu.yd. place measurement, including shale and some harder rock. The digging is done by a 1-yd. Thew steam shovel, loading 1½-yd. Koppel steel dump-cars hauled by mules along a narrow-gage track on the floor of the excavation (Fig. 1). At the lower edge of the lot is built a timber hoisting-tower with inclined hoistway in which a 5-yd. dumping skip travels. The skip is patterned after mine or furnace hoist models, though built of timber. The bottom of the hoist is in a pit below the bottom of the excavation, and the narrow-gage cars thus are able to dump directly into the skip. At the top of the hoistway, above the street, the skip tips its load into motor-car trucks (Fig. 2). Three trucks and three trailers are in use, each of about 5 cu.yd. capacity. The haul to the dumping-board is about 1 mi., and some 400 trips are made in 24 hr., nearly three-quarters of the total being handled in the night hours, on account of the clearer streets.

The dumping-board is located on the Allegheny River above the Ninth St. bridge. It is a sort of pontoon bridge, consisting of a planked roadway carried on a pair



EQUIPMENT FOR HANDLING EXCAVATION FOR WILLIAM PENN HOTEL, PITTSBURGH; JAMES L. STUART, CONTRACTOR

(Dump cars loaded by steam shovel; dumping-skip hoist to lift spoil to street and load the wagons.)

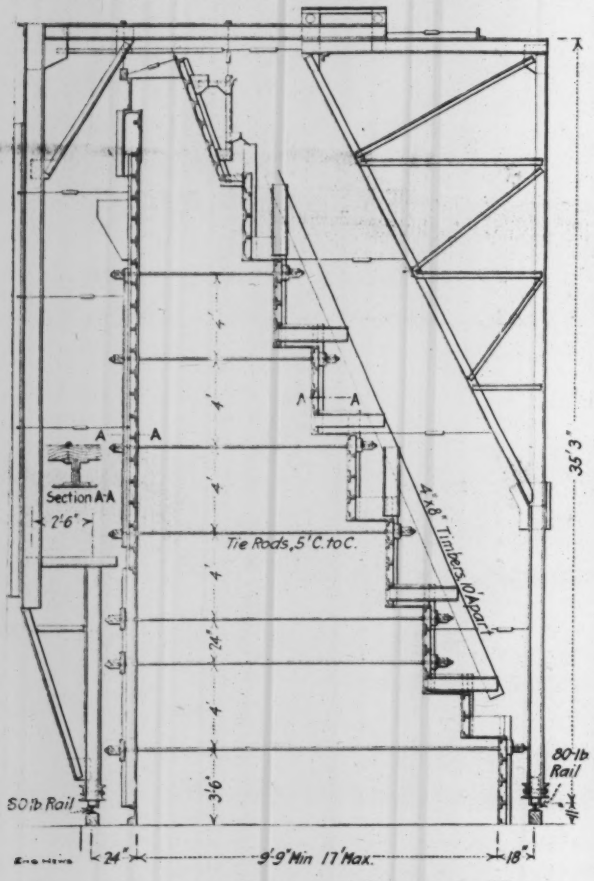
of girders whose outshore end is supported by two scows. Under the bridge is a bin, into which the trucks dump through a trap in the roadway planking. At the end of the bridge a turntable is built up on the scows. The truck after dumping is turned here and returns to shore running forward. The spoil is taken away on barges carrying 3-yd. boxes, filled from the bin; at the dump the boxes are lifted off by a derrick.

Steel Traveling Forms for Retaining Walls

In the construction of the reinforced-concrete retaining walls for track-elevation work at Chicago, the Rock Island Lines are using traveling forms, some of timber and some of steel. The walls are built in 35-ft. sections.

The accompanying cut is a sectional elevation of the steel form. It consists of a gallows frame traveling on double-flanged wheels on a pair of rails, the width of form (and gage of tracks) varying from 13 to 21 ft., according to the size of the wall. The width is varied by sliding the rear part of the frame inward or outward, each top cross-beam of the frame being made in two overlapping sections, as shown. The faceplate rests on a longitudinal sill and steel channel and is attached to the cross-beam of the gallows frame, while it is tied back to the rear of the form by a series of tie rods.

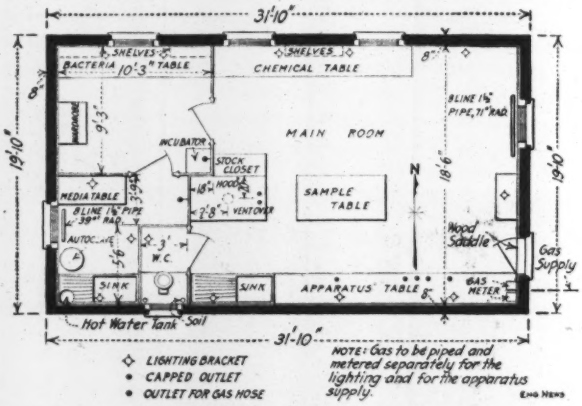
The steel forms were built by the Blaw Steel Construction Co., of Pittsburgh, Penn., and were designed by them in conjunction with the engineers in charge of the work, which is being done by the railway company under the direction of R. H. Ford, Engineer of Track Elevation.



Steel Traveling Forms for Retaining Walls

A Compact Laboratory for Sewage-Purification Experiments

An experiment laboratory built by the Bureau of Sewers of the Borough of Brooklyn, New York City, is shown in the accompanying plan. The laboratory is designed to handle a large number of samples daily from the various units of the sewage-experiment plant, located at the 26th Ward pumping station, near Jamaica Bay. E. J. Fort is Chief Engineer and George T. Hammond is Engineer of Design of the Brooklyn Sewer Bureau, and William T. Carpenter is chemist-in-charge of the laboratory.



Sewage-Purification Experiment Laboratory, Brooklyn, N. Y.

Moving an Old Stone Church with Screw Jacks

The Mott Haven Church, New York City, an old brownstone structure built in 1853, was recently moved to a new position on the same lot. The building formerly fronted on Third Ave.; it was moved back 50 ft. and swung around to face 146th St.

The first procedure was to tie across inside the building with steel cables fastened to beams spanning the outside of the windows. Holes were broken in the foundation to permit the placing of longitudinal or ceiling sticks. Cross-timbers were placed under these, running in some instances the entire width of the building and in others only through the wall, being supported by cribwork on the inside. Screwing sticks were then placed longitudinally under the cross-timbers and 150 hand jacks placed under the screwing sticks. The weight was thus taken off the stone foundation and the latter demolished.

About 15 well soaped rails were placed under the building, extending in the direction of proposed movement. The jacks were then removed and strapped on their sides to the rails, so that their heads pointed in the direction of movement and pressed against the screwing sticks (the other timbering had been removed). The screw jacks, acting horizontally, moved the building as desired.

The church was moved by the Damm House Moving Co., 281 E. 144th St., New York City, in about a month. The gang comprised 15 men and a foreman.

A Useful but Inexpensive Boat for Surveyors

By F. W. Salmon*

The boat shown in the accompanying figure can easily be made in two working days by any two men having a little handiness with tools. If pine pitch is used for the outside, instead of paint, and "enamel" or paint mixed with a good proportion of quick-drying varnish for the inside, it can be put in the water and used the evening of the second day—provided that the material is roughed out to size in a sash-and-door factory or similar mill.

To get the proper shape of the sideboards, I carefully made a small model of the outer surface to scale and drew a piece of strong paper over this tightly and marked the edges; on removing the paper of course there was a plain template of the outside of the skin, from which the figures are given to enable anyone readily to reproduce it. I have made several boats from "sawn stuff" by such templates and find that they come out amply close to the intended dimensions for general use and it saves a lot of time, labor and money.

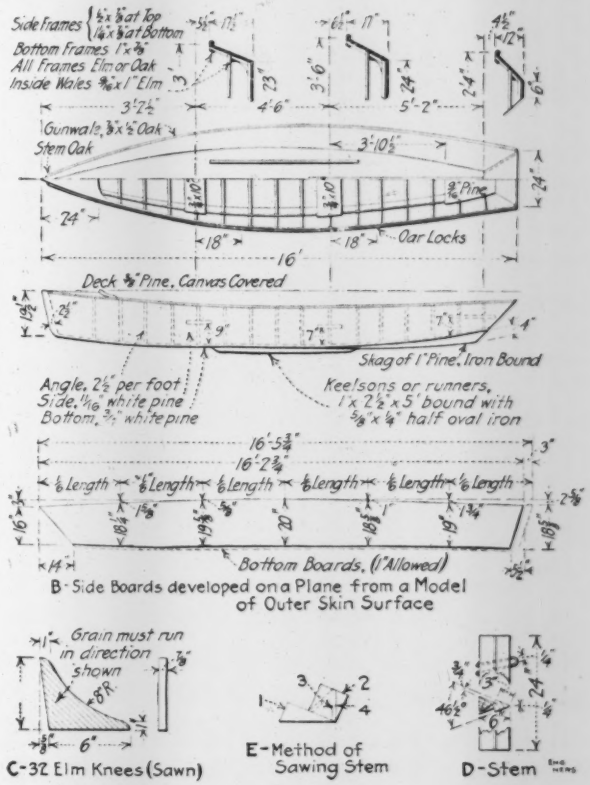
The boat handles well in choppy water. As the stern is undercut, the bow rises quickly to waves, keeping the boat dry. There being no deck, there is ample room for poles and tents. On ordinary waters, four men can be carried safely and well, or two men and a camp outfit.

If made of pine or basswood, the boat weighs about 250 lb. with four 8-ft. ash oars and rowlocks. The material costs some $12, where one man goes to the mill and lays out the pieces for cutting. As these millmen do not often get out material for boats, I have shown in *E* the scheme of sawing the stem. Generally, for a boat of this style and size it is made out of a piece of 6x6-in. timber. Tack on two wedges, 1, cut at 23¼° angle; then on a circular ripsaw cut off the piece 2, and after lowering the saw (or raising the saw-table) make the cut 3; after this the timber can be reversed end for end on the wedges and the other side cut so as to give the general outline desired and the second cut 3. Remove the wedges and make the cuts 4 from each side. To set up the boat, first the frames at the seats are rigidly put together with eight-penny iron-wire nails on form boards secured to a stiff plank, or a 4x4 in. Then the two sides, sawn as shown, are drawn down on these with ropes and the stem carefully fitted and nailed. Care must be taken that the distance from the stem to the seat on the right is exactly the same as on the left, measured along the top edge of the side, to insure having the seats at right angles to the center line of the boat when finished. Fit the stern carefully and secure all parts well. Dress off the bottom edges of the side planking, after turning the boat bottom up, so that the bottom boards will be tight. Put these on lengthwise after trimming the stem.

The boat can next be turned right side up, the bottom and side frames fitted and secured, the elm knees marked and cut at the angle to fit each place and all nailed, the inside wales and outside gunwale fitted and well nailed, and the stern seat and front deck put in.

When assembling the parts, surfaces that come in contact should be given a coat of paint, such as thick white lead ground in oil and thinned with spar varnish and turpentine. This is not very often done in the cheaper boats, but adds to their tightness and durability. The seams may be calked lightly with cotton where necessary. The boat should be painted inside, turned over and pitched with hot pine pitch if wanted for immediate use and at the least expense. The outside may be painted if more time can be allowed and more expense incurred.

An iron U-bolt should be put through the stem post, as shown in *D*, for the painter—which is usually a ⅝-in.


Side Frames
Bottom Frames
All Frames Elm or Oak
Inside Wales
Gunwale
Stem Oak
Oar Locks
Deck ⅝" Pine, Canvas Covered
Skag of 1" Pine, Iron Bound
Angle, 2½° per foot
Side, 1/16" white pine
Bottom, ⅜" white pine
Keelsons or runners,
1"x 2½" x 5' bound with
⅝"x ¼" half oval iron
Bottom Boards, (1" Allowed)
B-Side Boards developed on a Plane from a Model of Outer Skin Surface
Grain must run in direction shown
C-3Z Elm Knees (Sawn)
E-Method of Sawing Stem
D-Stem

Plans of a Surveyor's Boat

hemp rope. The rowlocks should be secured to the boat by a cord or small chain. Some people like a floor inside on the frames; two boards 10 in. wide, of ⅜- to ½-in. stuff, can be laid loose or secured.

Few tools are required if the material is roughed out at the mill—a hammer, hatchet, smoothing plane, firmer chisel, brace and bits, including a screwdriver, and a crosscut saw, cover everything.

*607 N. 20th St., Birmingham, Ala.

NOTES

A Real Novelty in Stadia Methods—J. Zwicky, of St. Gallen, Switzerland, has brought out a radical novelty in the field of stadia measurement. Instead of using two horizontal crosswires in the telescope reticule as stadia interval, he forms a horizontal stadia interval by using two telescopes whose horizontal axes make a small angle with each other. In the instrument as practically constructed, one of the telescopes is mounted immediately above the other, and a link connection causes the two telescopes to rotate together vertically. Since both telescopes revolve in vertical planes, the intercept which they cut off on a horizontally held stadia rod is proportional to the horizontal distance between instrument and rod, instead of being proportional to the slope distance (as with upright rod held normal to the line of sight, or with horizontal rod and ordinary stadia wires), or propor-

tional to a function of the slope distance (as with ordinary vertical stadia rod).

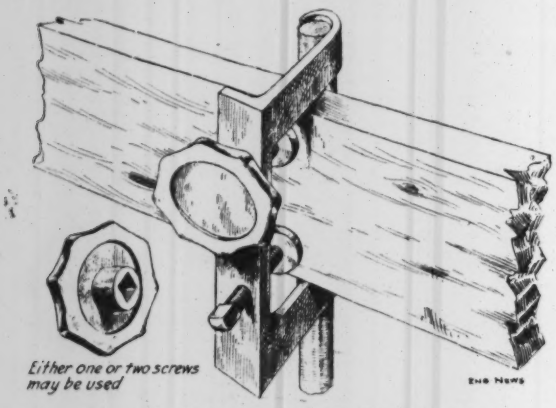
The two prime advantages of this instrument and stadia method are claimed to be: (1) the possibility of using a much smaller stadia ratio than 100, thus permitting the attainment of much greater accuracy on ordinary lengths of sight; (2) the elimination of all calculations to get horizontal distances. The former advantage permits of getting a precision of better than 1 : 1000. In a survey of an 80-acre tract, where all measurements (except those in woodland, where the tape was used) were made by this stadia method (with interval 1 : 20), a precision of about 1 in 3000 was obtained.

Holding the rod in horizontal position needs two rodmen instead of one, which is a countervailing disadvantage.

To eliminate calculation for obtaining elevations also, a reduction chart is attached to the side of the transit standards and a pointer fixed to the horizontal axis of rotation moves over this chart as the telescope is revolved.

The inventor describes the new method and instrument in the "Schweizerische Bauzeitung" of Sept. 5, 1914.

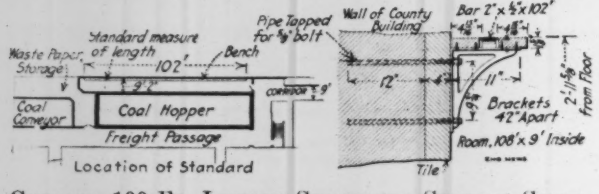
A Reusable Batter Board — The accompanying drawing shows the details of a batter board device, patent for which has been applied for by R. H. Peck, an engineer of New York City. The device may be used in any kind of work re-



A Patent Batter Board

quiring side batter boards, but in the diagram it is illustrated in use on a sewer trench. It consists of two iron rods, which are driven into the ground, and for each rod a hook-end yoke which engages the iron rod and at the same time allows between the rod and the spring yoke-bar a plank anywhere from ¾ in. to 1¼ in. thick. This plank, which is used for the batter board, is then clamped tight against the vertical iron rod by a screw with a loose flat-plate head.

A 100-Ft. Length-Standard Bar has been installed in a special room (9x108 ft.) in the basement of the city hall at Chicago, to be used for standardizing tapes and other measures. The installation of such a standard bar was proposed several years ago by the Western Society of Engineers, and after many disappointments and discouragements, the committee having the matter in charge secured the coöperation of the architects for the new city hall (Holabird & Roche) and the Commissioner of Public Works. The bar is 2x½ in., 102 ft. long, made in six pieces (for convenience of transpor-



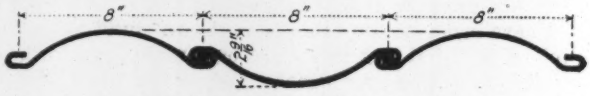
Chicago 100-Ft. Length-Standard; Section Showing Bracket Mounting

tation), which were welded together in place by the oxy-hydrogen flame. It rests on rollers, secured to brackets 42 in. apart, which are so attached to the wall as to permit of adjustment in a vertical plane.

The rod being in proper place and level, small plates of an alloy of 90% platinum and 10% iridium, ⅛ in. diameter, were inserted flush with its top surface at each place where a graduation mark was to be placed; at zero (0), 1 ft., 1 yd., 1 meter, 10 ft., 25 ft., 50 ft., 66 ft., 20 meters, 30 meters and 100 ft. At the zero end of the rod there is provided a clamp for holding the end of a tape line to be tested. At the other end there is provided a spring balance. The rod was graduated in October, 1913, by Prof. L. A. Fischer, of the U. S. Bureau of Standards. It was officially accepted by ordinance of the City Council on Mar. 30, 1914. It is put under the charge of the superintendent of maps, and a set of rules has been drawn up governing its use. A bronze tablet on the wall sets forth that this standard was presented to the city by the Western Society of Engineers and installed by Peter Heer. The society's committee which has had the matter in charge is composed of G. A. M. Liljencrantz (chairman), C. D. Hill and A. C. Schrader.

A New Steel Sheetpile of Very Light Weight has just been brought out by the Lackawanna Steel Co. It is of the section shown in the cut herewith, and is intended to be used for core walls and cutoff walls of dams or levees, protective cutoffs in difficult excavation work, etc.

The pile is 8 in. wide c. to c. of interlocks, and is curved transversely to a versed sine of 1¾ in. Alternate piles are turned in opposite directions, and thus produce a wall thickness of 2⅞ in. out to out. The metal thickness is ⅜ in.; the pile weighs 7.66 lb. per lin.ft., or 11.50 lb. per sq.ft. of



New Lackawanna Sheetpile

wall. The resisting moment of the pile section (taken singly), at 16,000 lb. stress in the extreme fiber, is 11,840 in.-lb.

This pile has been used recently in some levee work on the Mississippi River, and a large amount is to be used shortly in subway construction in New York City, for protecting existing foundations against soil movement.

Filling a Park Area with Spoil; Transportation Difficulties—In Cleveland, Ohio, some 85,000 cu.yd. of excavation from the site of the W. Bingham Co.'s new building on West Ninth St., near St. Clair Ave., is being used for filling low-lying park area some 4½ mi. away. Bernstein Park, a newly created playground on waste low land alongside a congested district, near East 37th St. and the Nickel Plate tracks, is being filled. The city pays 15c. per yd. for unloading and spreading, and the contract price for the excavation is 87c., so that the contractor receives in all $1.02 per cu.yd. Apparently he is handling it at a fair profit, in spite of quite unfavorable conditions. The material is a moist sand and clay mixture. It is handled from the excavation directly into Western air-dump cars on the Big Four tracks near the excavation site, and is transported by the contractor's own locomotives (with railway-company crews) to the park, via Big Four and Nickel Plate. There is considerable delay at the transfer point, and also at the Nickel Plate viaduct over the Cuyahoga River, which is being reconstructed, and is operated single-track under slow orders. The biggest day's handling has been 20 cars averaging 30 cu.yd. The Fred R. Jones Co., Inc., of Chicago, is the contractor.

Rules for Setting and Starting Water Meters—Before cutting the service pipe, flush it thoroughly to remove the sediment, sand and gravel which are liable to make trouble if washed into the meter. After cutting and threading the pipe, remove thread-cutting chips from inside the end of the pipe.

If the service to be metered is new a temporary flushing pipe the length of the meter should be placed in the meter couplings and after a few days' use of water the flushing pipe removed and the meter installed.

Do not use paint or joint compound freely on the pipe joints between the meter and the mains as it is liable to wash into the meter and clog the working parts.

Keep the tin caps on the threaded spuds of the meter unti the last thing before attaching to the pipes—then blow through the meter to be certain the mechanism is operative.

Disk meters operate successfully in all positions but for best results set them level.

After the meter is set open a faucet and turn the water on slowly so it will gradually expel the air and fill the meter. Mixtures of air and water under full pressure resulting from not observing this rule are liable to strain and damage the meter's works.

Hot water ruins the hard-rubber measuring disks of meters. Where it may be drawn back through the meter when the mains are emptied or forced back through the meter from overheated boilers, use a check valve on the pipe to give as much protection as possible, and a pressure relief valve on the boiler.—From a pamphlet on "Setting, Repairing and Testing Water Meters," issued by the Buffalo Meter Co.

Editorials

Heavy Construction Work on the Grand Trunk Pacific Ry.

While the Grand Trunk Pacific Ry. has secured a specially favorable location for the Rocky Mountain section of its transcontinental line as far as grades and a low summit elevation go, the construction of this part of the line has been attended with exceptional difficulties. These difficulties arise from three causes: the severe winter climate, the topography and almost inaccessible character of the country, and the character of the streams which had to be utilized for transportation of material.

The necessity for expediting the progress of the work made it necessary to commence construction at various points, and this, in turn, made necessary the transportation of men, machinery and supplies to points not only difficult of access but often cut off entirely from any means of communication. These conditions of carrying on the work are illustrated in an article published elsewhere in this issue describing some of the bridge substructure work, and written by one of the men in direct charge of this construction.

In ordinary railway construction it is usual practice to build temporary bridges in advance and thus to have a line of communication open with the base of supplies. But in the case of the Grand Trunk Pacific Ry. there were many cases where temporary bridges could not be built or would be constantly liable to destruction, and it was desired to have the substructures for permanent bridges built in advance, so as to be ready for the steel superstructures when the tracklaying reached them. This necessitated establishing construction camps in distant mountain regions, where the means of communication were very limited and were liable to be interrupted entirely for considerable periods. Under such conditions ample supply of provisions, equipment and machinery parts was essential. Still more essential was the placing of the work in the hands of resourceful men who could turn emergencies into opportunities and could keep the work in progress whatever might happen.

Where the line follows the general course of the Fraser River, the river was adopted as a means of distributing material to the construction points, including the three long bridges which cross it. The river is navigable only at high-water period, which is during the summer, and is then too high and turbulent for construction work in the stream. The low-water period available for bridge construction occurs during the winter, which is very severe, the temperature continuing at 40 to 50° below zero for considerable lengths of time. Under these conditions, much of the heavy material and supplies had to be taken to the sites in summer, by means of scows floating down a dangerous channel with a wild current and numerous rapids. In winter, with everything frozen solid, the coffer-dams were built, excavations made, and concrete deposited for the foundations and piers. But the work was planned to meet these conditions and was carried out successfully, while the concrete proved to be of excellent character, indicating once more that proper precaution and expense can make winter concreting quite practicable.

In winter there was communication by sled on the river, except when the snow was too deep, and this was the most favorable time to deliver material, owing to the dangers of navigation in summer. During some winters, there is comparatively little snow, and in the hope of experiencing this condition the bridge contractors purchased and delivered a large motor truck with trailer wagons. Their hopes were not fulfilled, however, and the heavy snow made this costly equipment quite ineffective. In one case, materials and plant were hauled by sleds about 150 miles over the frozen river, between points about 100 miles distant by the future railway but quite inaccessible by land. For another of the bridges, a considerable part of the material was carried on scows for nearly 300 miles.

Ben Franklin Vindicated

The decline in popularity of lightning rods, following the pernicious activity of rascally agents, left a stain on the scientific reputation of the great and wise Ben Franklin, who developed this protection against thunder bolts. Scientists have stoutly defended the value of such equipment, if well put up, but, nevertheless, practical men, often speaking from bitter experience, have maintained continuously for generations that the rods have proved worse than useless.

Two valiant defenders of the faith, Professors J. B. Reynolds and W. H. Day, of the Ontario Agricultural College, not contented with the inconclusive deadlock of theory and claimed fact, set out to find the truth—in practicable demonstrable form. For ten years, first one and then the other industriously collected all possible information about buildings reported struck by lightning in Ontario. At the end of this time (1910), they had data on 599 buildings struck by lightning. Of this number struck, 317, or 53.6%, were burned, but only 18 of the buildings struck, or 3%, had rods and only three of these, or 16.6%, of the protected buildings were burned. Having these interesting but incomplete figures, the investigators desired to know further the number and experience with unrodded buildings in the province, so that they might complete their case—reasoning that if rods neither prevented nor induced strokes the ratio of damaged to undamaged structures in the unprotected risks would be of the same order of magnitude as in the rodded.

Great difficulty was found in securing the desired data. Eventually, however, the Provincial mutual insurance companies were interested in the studies and reports covering about a fourth of the province were secured after some delay. These showed that 21% of insured farm buildings were rodded and that of all those struck only 1½% were rodded. Out of 7000 unprotected buildings, 37 were struck; out of 7000 protected ones only two

were struck. Therefore, 35 were saved out of 37 expected to be struck, or a probable protection of 94.5% and that with uninspected rod construction.

Prof. Day visited Iowa and Michigan to inspect the insurance reports and methods of protection there. In Iowa, he found that the total claims paid for lightning damage in eight years amounted to $4464 on rodded buildings and $341,065 on unprotected ones. Apparently then, for each dollar paid on rodded risks $76 was paid on unrodded. The rods were not inspected and some of the losses probably were due to poor construction. Even so, the protection shown was 98.7%. In Michigan, one mutual company insuring only rodded and inspected buildings, in four years paid $32 claims on $55,172,075 risk. Another mutual company taking both protected and ordinary risks paid $32,269 in claims on a total of $59,567,272 in the same period. The loss was practically all on unprotected buildings aggregating $47,753,818 in value of risks. Comparing the two companies,for each $1 damage on protected buildings there seemed to be paid $1168 on unprotected ones—an obvious protection of 99.9%. All this and more is set forth at length in a recent bulletin of the Ontario Department of Agriculture.

Regarding the technique of the rod construction so successfully employed in these states, it is of interest to know that, where knowledge was available, there appeared to have been used more or less of an approach to a cage of conductors about the building. The rods were fastened both close to and away from buildings but without insulators. Deeply buried ground plates and rods were found and where these groundings proved defective there invariably developed disaster.

The worthlessness of the old lightning rods, of course, was the fault of the loquacious fly-by-night agent who carelessly put up his cheap affairs, gathered his money and disappeared, leaving disaster and ruin for many a farmer on the approach of the first heavy electrical storm. A deliberate campaign to discredit the great American philosopher and patriot could not have worked as well. It is a source of much satisfaction to see definite figures which substantiate the soundness of his scientific knowledge as well as that of a long line of later physicists.

The Submarine Vessel as a Factor in Naval Warfare

The destruction wrought upon United States wooden war vessels by the Confederate ironclad "Merrimac" in Hampton Roads during the Civil War, closely followed by the conflict between the "Merrimac" and the "Monitor," changed the entire art of naval construction. It is quite within the possibilities that the recent sinking of three British cruisers in the North Sea by a German submarine boat will create an equally profound change in the world's navies. The control of the seas has hitherto belonged to the nation able to build and to man the largest number of fighting ships, with armor and armament sufficient to enable them to vanquish their antagonist. But of what use to build these huge floating fortresses at enormous expense if they and their crews are at any time likely to meet destruction by an insignificant antagonist hidden in the ocean depth?

It was the dream of the designers of the submarine boats to accomplish this very thing. During the fifteen years or so since the first submarine boats were built, there has been no war between nations owning sufficient submarines to test the possibilities of their action. Yet an eminent British admiral, only a few weeks before the outbreak of the war, expressed his belief that the development of the submarine boat had reached a stage that rendered battleships obsolete. This prediction is recalled in connection with the news of the recent serious disaster to the British fleet.

Of great significance is the detailed account of the circumstances under which the British cruisers were sunk. As has been fully reported in the newspapers, it appears that the doomed cruisers were in the open ocean far from the coast with no thought of an enemy being near. It may never be positively known whether anyone on the first cruiser sunk saw even the periscope of the attacking submarine before its torpedo exploded. At any rate, the attacking vessel, if seen at all, was seen too late to make any effective defense. The two other cruisers, a mile or two distant, saw the plight of their sister vessel and supposing it to have struck a floating mine came near to rescue the crews struggling in the water, when the submarine torpedoed these cruisers also. The number of men lost in this brief and inglorious battle, if battle it can be called, equalled the losses in some of the most famous naval battles in history.

Another significant outcome of the loss of these three cruisers is the issue of orders by the British Admiralty that in case one vessel of a fleet is torpedoed by a submarine boat, other vessels in the fleet must look to their own safety and not run the hazard attendant on rescuing the crew of the sunken vessel. It is difficult to read any other interpretation from this order than that the proper tactics for a naval vessel, as soon as it learns that a submarine boat of the enemy is near, is ignominious flight. It may be the most powerful cruiser or the latest superdreadnought battleship, yet its fighting power is of so little avail for defense against this hidden foe that its only refuge is to seek safety through superior speed.

It is fair to say, on the other hand, that the submarine boat, while it has reached a high degree of mechanical perfection, is still subject to serious limitations. Were it not for these limitations, the losses of naval vessels torpedoed by submarines since the beginning of hostilities would already have been far more numerous. The submarine can carry only a limited amount of supplies; it must operate either within a definite radius of a shore station or else it is dependent on a supply ship. Its speed is limited; and what is most important of all is its inability to locate its adversary when running submerged.

The modern submarine boat is more properly termed a submersible boat. In normal operation a considerable part of its hull is above the surface. On sighting and identifying an enemy's vessel, the boat sinks in the water leaving only its periscope above the waves. From this point of observation, the course of the submarine is directed until it is near enough to the enemy so that there is danger of discovery. From that point onward its journey must be entirely under water, coming to the surface only when absolutely necessary to verify the course and distance. If at such a time some lookout on the endangered vessel discovers the submarine, instant efforts will be made to discharge a machine-gun volley at the periscope. If successful, the blinded submarine will probably come to the surface where its thin hull will be quickly pierced by shots.

The tactics of the submarine, therefore, are to seek an enemy's vessel when darkness or storm or fog makes observation difficult, so that its approach may be undiscovered.

The difficulty of navigating a submarine vessel under the conditions of attack and of effectively discharging its torpedoes are well known and have caused many naval authorities to regard the submarine boat with skepticism and to continue to pin their faith to big battleships and cruisers.

Nevertheless, the mere possibilities of submarine attack have already revolutionized the naval blockade. The close blockading, which was the ordinary practice in warfare a generation ago, is now too hazardous. It is even an open question, which the present war may settle, whether such a blockade with the vessels perhaps 200 miles off the coast at times can be considered an effective blockade in international law.

It would be indeed a marvelous event in the progress of invention and discovery if the development of submarine navigation should render obsolete the enormously expensive cruisers and battleships on which the great powers of the world have chiefly relied for naval supremacy. It is quite possible that the submarine boat may so greatly increase the defensive power of the smaller nations that they may make themselves invulnerable from an attack by sea on the part of even the most powerful nations by the possession of even a small fleet of comparatively inexpensive submarine boats.

Standard Specifications for Steam-Boiler Construction and Operation

Of all the work done by engineering societies, probably the most valuable and important is the establishment of standard practice on matters with which the members of the Society have to deal. A task of this sort which is just now attracting much attention is the work which a committee of the American Society of Mechanical Engineers is doing in framing a standard specification for boiler construction and operation suitable for enactment by State legislatures.

The first appeal to the Society to take up this task came from the boiler manufacturers. The State of Massachusetts a number of years ago passed a law governing the construction and inspection of steam boilers, which has without a doubt been a great factor in reducing the risk to life and property from steam-boiler explosions in that state. In recent years, a half-dozen other states have followed Massachusetts' example and while they have generally taken the Massachusetts law as a foundation, they have made various minor changes which have become the source of a vast deal of trouble to the boiler manufacturer.

Slight differences in the quality and character of the material, acceptable in one state and not acceptable in another, make it necessary for the boiler manufacturer to keep materials for use in boilers for different states separate as they pass through the shop. The difficulties and expense involved in this in a large establishment can readily be understood. Besides this, there is the risk that through some unintentional error, material intended for use in one state may be accidentally used in a boiler intended for use in another state.

This legislation is already a most serious matter to the boiler manufacturers, when only half a dozen states or so have laws in force regarding steam-boiler construction. One can well imagine the situation, therefore, if instead of a half-dozen states, thirty or forty states had each laws governing boiler construction differing in various details and requirements. Such a condition, however, has actually been threatened. The very fact that some states have laws specifying what boiler materials will be accepted operates to give them the better class of steel and of boilers, and the boiler makers sell the material which would be refused in states which have no such legislation.

It is a realization of this condition, as well as a general movement toward more stringent protection of public safety, that has caused the authorities of a dozen or more states to draft laws upon the subject which are likely to be presented to the legislatures when in session next winter. It is, in fact, authoritatively stated that a number of states would have passed laws a year ago save for the urgent appeals of engineers that action should be delayed until a model law had been framed by the American Society of Mechanical Engineers which could be generally adopted.

The Mechanical Engineers' committee which has been at work upon the proposed standard code completed a preliminary draft last spring which was printed and sent to 2000 engineers representative of all the different interests connected with boiler construction, operation, inspection, etc., with requests for detailed study and criticism. While some preliminary discussion of this tentative draft took place at the St. Paul meeting of the Society in June, the main discussion took place at a special meeting of the committee held in the Engineering Societies' Building, New York City, on Sept. 15, at which nearly 150 engineers were present. The discussion was most active and in some instances heated. Eventually, however, a spirit of harmony and willingness to compromise prevailed.

The discussion made clear that a specification for steam boilers to be embodied in a statute should be general rather than specific. It should embody only the most essential features necessary to safety in boiler construction. It was clearly brought out that to embody in such a code certain specific requirements which might be advantageous for certain classes of boilers would operate as a serious handicap in the construction and operation of other classes of boilers widely different in their design.

The committee is now engaged in the large task of analyzing and studying the large amount of written and oral discussion and criticism it has received and will, it is expected, present its final report for adoption by the Society at the December meeting. Doubtless there will be further active discussion there on some controverted points in the specifications. It seems likely, however, that the report will be finally adopted at that meeting and made available for such state legislatures as choose to act upon it, since further delay, as has been already pointed out, would mean a still worse chaos in state legislation on boiler construction.

It is of interest to note that this voluntary action by a technical society seems to have been practically the only way to save a very important branch of industry from an impossible situation. The desirability of protecting the

public safety by making boiler construction and operation a matter governed by law will be almost universally conceded; but while the Federal Government under the Constitution may and does control the construction of steam boilers used on vessels navigating waters over which the United States Government has jurisdiction and also controls the boilers of railway locomotives employed in interstate traffic, the construction of other classes of boilers has been held to be a matter purely within the police power of the several states and not subject to Federal regulation.

If, however, each state were to indepently draft a law regulating steam-boiler construction and inspection, it would be almost as great a barrier upon interstate commerce in this industry as would exist if the several states erected tariff walls around their borders and collected customs on all imports. It is, therefore, the highest kind of public service to have a national engineering society step forward in this difficult situation and take the lead in framing a law which will have the professional prestige of the society behind it and can be accepted by the various state legislatures, therefore, as a safer and more intelligent guide to their work than they could hope to secure from any experts within their own boundaries.

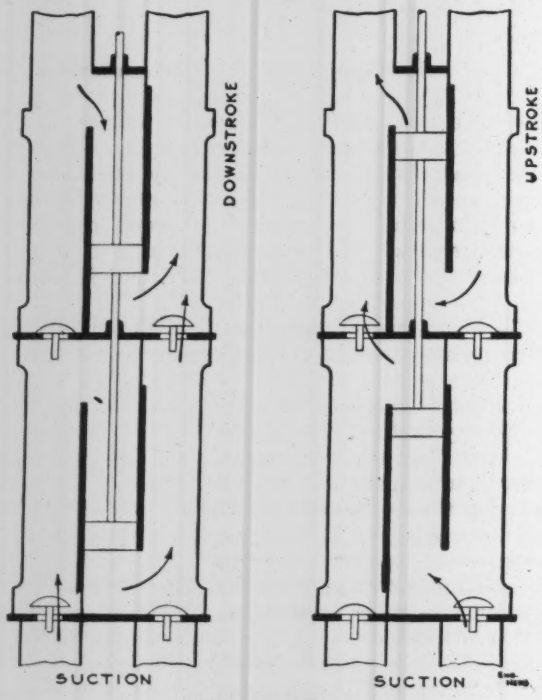
It is worth emphasis, too, that the American Society of Mechanical Engineers is probably the only technical society which could have successfully undertaken this work. Were any commercial organization to take it up, representing any special trade or interest, such as the boiler manufacturers or the steel manufacturers, for example, legislators would naturally be suspicious that the legislation offered was framed to protect some commercial interest, and however unjust or unfair such a suspicion might be, it would have undoubted weight in hindering the adoption of such legislation in many states.

The model law to be framed by the American Society of Mechanical Engineers, however, should be free from any such handicap. There is every indication, moreover, that by the time the law is finally perfected all the interests concerned will be satisfied that they have had a fair hearing and that their representatives have received impartial consideration and they should therefore be counted on for its support. The Society in this task, therefore, is rendering a service not only to the public but to the entire engineering industry.

Letters to the Editor

Another Wonder Pump

Sir—About three years ago the writer was called upon to analyze the working of a pump, which, while evidently similar to the one described in the letter of L. M. H. in the issue of Aug. 27, is far ahead of it in the matter of efficiency—in the mind of the inventor. The accompanying sketch shows the operation of the pump, explained as follows:



A Wonder Pump

DOWN STROKE—The two pistons force water up the right hand pipe, the lower piston draws water into the left hand lower cylinder, the upper valve on left hand side is closed, so the weight of water in left hand pipe is forced against the top of the upper piston thereby balancing the same amount of water in the right hand pipe.

UP STROKE—The upper valve on the right closes, forcing the weight of the right hand water column against the bottom of the upper piston and thereby lifting the water in the left hand pipe, while the lower piston draws water into the lower right hand cylinder. "We thereby get a complete (?) balance on all water above the pump in each pipe, making it possible to lift the water any distance by the use of just enough power to pump the water the length of the stroke plus friction in the pipe. The pump requires two pipes of the same size the full height the water is to be raised.

The 200% efficiency of the pump mentioned by L. M. H. pales into insignificance beside the performance of this prodigy. Conceive of the ease and low cost by which water could be raised 500 ft. by the expenditure of merely enough energy to raise it one foot (plus a little friction), on a 12-in. stroke!

L. J. C.

Moscow, Idaho, Sept. 2, 1914.

A Problem in Mechanics

Sir—The problem stated below may interest readers of Engineering News. While the principles involved are simple, the writer found it difficult to demonstrate them to five or six intelligent people, after a week of intermittent discussion followed by an experiment carried out with all conditions exactly as in the problem. Among those interested was a professor of physics, who was not

convinced, even after the experiment! Here is the problem:

A man on shore is exerting himself to his utmost in pulling a boat toward him by means of a long rope. The off-shore end of the rope is not made fast to the boat, but is held in the hands of a man in the boat. If the man in the boat exerts himself by pulling the rope into the boat, will the boat move faster than if he does not so exert himself, and why?

There is no "catch" in the problem and no question of accelerated motion. Those to whom the problem is a puzzle reason as follows: How can the boat move faster without an increase of tension in the rope; and if the shore man is already pulling his best upon the rope, how can the tension be increased by the mere fact of the man in the boat going to work?

The answer to the problem is that the boat will move faster when both men haul in the rope. The fallacy in the statement above which makes the problem a puzzle to many is that the maximum force a man can exert is a constant quantity. It is not a constant quantity, but is a function of the speed of application. To express it in simpler terms: The force exerted by the man on shore is not so great as he might exert were he pulling on a rope anchored to an immovable object. The man in the boat is therefore capable of exerting a greater force on the rope than he does when merely acting as an anchor. When he attempts to do this, the increased pull checks the speed of the shore man with a concomitant increase in the force which he exerts, forming the increased reaction to the increased pull from the boat. Hence the tension in the rope increases, and therefore the speed of the boat increases, even though the rope goes ashore more slowly, because the speed of the boat is now the sum of the speed of the rope going ashore plus the speed of the rope entering the boat.

In an experiment carried out with a rowboat, the shore man acting alone was able to pull the boat over a given course in 21 to 23 seconds. When the boatman applied himself also, the boat covered the same course in 14 to 16 seconds.

The resistance to a boat moving through the water is roughly proportionate to the square of the speed. If we assume that the maximum force exerted by a man is inversely proportional to the speed of application, it is easy to make the problem quantitative, and to show the speed with two men as against one to be an increase of $\sqrt[3]{2}$ times.

While the men are supposed to apply themselves in the same way, it makes no difference what that way is. They may take in the rope hand over hand, they may run bodily back with it or they may turn a windless. The same conditions would hold if we substituted steam winches or electric winches.

CHAS. A. GILCHRIST.
2401 Le Conte Ave., Berkeley, Calif., Sept. 11, 1914.

Creeping of Asphalt Block Pavements

Sir—In ENGINEERING NEWS of July 16, 1914, p. 130, there are some notes on the creeping of asphalt-block pavements. Though the instances given show more movement of the courses than commonly found, practically all asphalt-block pavements show this creeping.

The first case noted by the writer was in 1907 or 1908 on the Southern Boulevard, south of Freeman St., New York City, a year or 18 months after the completion of the pavement. The east roadway carrying uptown traffic has a down grade of about 4% in the direction of travel, and the courses of blocks showed a movement of 18 or 20 in. then. Blocks, which as laid were 12x5x3 in. thick have been found squeezed by the traffic to 16 in. long, 6 in. wide and 1½ in. thick, and in other cases to 5 in. thick and proportionately narrow.

In the writer's opinion the creeping is due to the traffic crowding the blocks closer together, a small movement at each joint amounting to a considerable distance in a city block. As there are about 240 joints in 100 ft., ⅛ in. on each joint would amount to 30 in. This space is filled by the spreading of individual blocks, most of which show slight spreading, at least on top.

The irregularity on asphalt-block pavements is also due in the writer's opinion to the spreading of the blocks permitted by the open joints. These will usually average about ¼ in. when the pavement is laid, but soon the blocks show absolutely close joints, only a skin of dirt separating adjacent blocks. This spreading of the block allows it to be gradually rolled out to a thickness of 1½ to 2 in., making a decided hollow, which rapidly increases in size, as it holds water and has to sustain blows of wheels as they drop from the higher blocks.

The creeping of the courses in wood-block pavement is also noticeable, but from a different cause. It is usually due to the swelling of the blocks at cuts or openings where the pressure has been relieved and the pavement is free to swell, thus allowing the courses to assume a curved line where originally they were straight.

R. A. MACGREGOR.
2428 Lorillard Pl., New York City, Sept. 8, 1914.

Record Season of Pavement Construction in Montreal, Que.—To the first of September about 25 miles of new pavements had been laid on Montreal streets since the present season's work began. This is about 250,000 sq.yd.

The Progress of Work on the New York Barge Canal is summarized by State Engineer John A. Bensel in the "Barge Canal Bulletin" for August. On the Champlain Canal from Whitehall, the southern end of navigation on Lake Champlain, south to Northumberland, a distance of 30 miles, the canal is finished. The completion of the entire Champlain Canal awaits the completion of the Troy Dam by the United States Government. A branch from the main line of the barge canal to Oswego on Lake Ontario will be finished next season, ready for the opening of the new waterway in 1916. Federal Government work will be necessary to deepen the harbor at Oswego to 12 ft.

Of the 346 miles of canal between Albany and Buffalo, about 70% has been completed and turned over to the state. At the western end the work is all completed from Tonawanda to a point about 6 miles west of Rochester. Work has been delayed east of Rochester by litigation over six railway crossings. This litigation has now ended, and the work will proceed rapidly, so that next year should see the completion of the work all the way from Rochester to Fox Ridge, near Syracuse, and between Fox Ridge and Utica.

The work on the canal terminals, which is being done under a separate bond issue, is also making rapid progress, and will be ready when the barge canal is completed. The Whitehall terminal is already finished, and the terminal at Albany has already received lumber vessels from Florida. The Troy terminal is under contract, and work has begun at Buffalo and Oswego.

A table in the report shows that on completed contracts for the barge canal work, $37,266,000 has been expended, and on contracts now in force, $31,600,000 has been expended, a total of $68,806,000 worth of work completed to Aug. 1. The total work completed to July 1 includes 87,690,000 yd. of excavation, 1,200,000 yd. of embankment, 2,416,000 cu.yd. of concrete, 1,408,000 cu.yd. of rough stone work of all classes, 22,000,000 ft. B. M. of lumber, and 82,000,000 lb. of metal work.

The Prismatic Astrolabe, A New Instrument for Determining Latitude and Time by Equal Altitudes

By David Rines*

The method of equal altitudes for the astronomic determination of the observer's position upon the earth's surface leads to results of such surprising accuracy that it has been termed incontestably superior to any other. As the name suggests, this method calls for the observation of celestial bodies in various portions of the heavens,

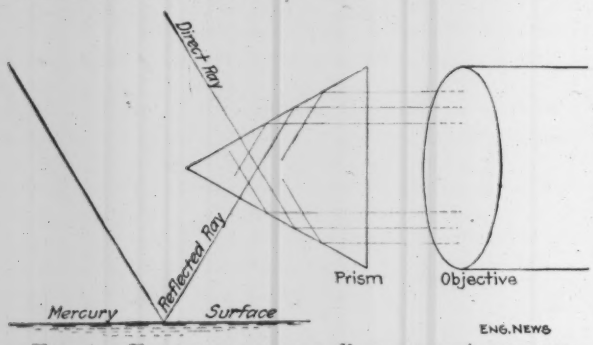


Fig. 1. Elements of the Prismatic Astrolabe

but always at the same altitude, the observation consisting merely in noting the time when this altitude is attained.

As the altitude itself is entirely eliminated from the results in the course of the computation, its exact value, affected by constant errors of graduation, eccentricity, level, collimation, azimuth, flexure, etc., is of no consequence, provided only that it is the same for all stars observed. The local time and the latitude thus obtained, free from systematic error due to these sources, are remarkably precise.

The method itself was introduced by Gauss, who first pointed out its advantages a century ago. Employing a sextant and artificial horizon, this illustrious mathematician, even with such crude apparatus, and with only three stars, obtained a value for latitude which excited wonder. After Gauss, others experimented with the sextant; but only the brighter stars can be observed with this little instrument. Very few of these can be found at a given altitude within a reasonably short period of time, and the small magnification necessarily employed to permit keeping the star in the field of view is not conducive to sharp observation. Sextant work cannot be relied upon for work of extreme precision.

Experiments were accordingly made with theodolites and other instruments rotatable around a stable vertical axis, and very good results were obtained by careful manipulation; but the artificial horizon was here replaced by some device like the spirit level, and this reintroduced the bugbear of systematic error. The method of equal altitudes, therefore, despite its advantages, though employed extensively at sea, was long neglected on land.

Recently, the French took hold of the problem, and, in their ingenious way solved it by inventing and improving a new instrument, "l' astrolabe à prisme," "the astrolabe with a prism," or the prismatic astrolabe. Of this, there are several forms, but the principle in all is the same. Like the sextant, the astrolabe involves the use of an artificial horizon, but it replaces the two separate sextant mirrors by a single equilateral glass prism. The prism is mounted, edges horizontal, with rear face vertical, in front of the object glass of a horizontal telescope rotatable on a vertical axis in a horizontal plane, and the whole—prism, telescope, mercury basin and other appliances—is supported on a tripod like a theodolite.

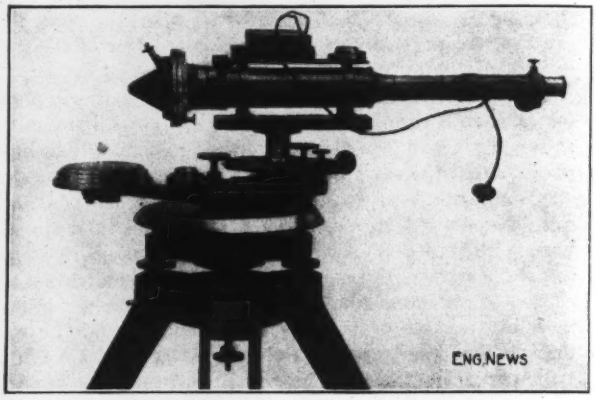


Fig. 2. Prismatic Astrolabe for Determining Latitude and Time by the Method of Equal Altitudes

One face of the prism receives light directly from the star, another from the star's image reflected in the mercury, and the two light rays, after interval reflection, pass through the rear face of the prism to the object glass. Stars are thus observed at a constant altitude of 60°.

For time determination, observations are made in the neighborhood of the prime vertical, where the altitude changes most rapidly; for latitude, near the meridian. As it is easily possible without field illumination to observe stars as faint as the seventh magnitude, a skillful observer may secure 30 to 40 stars in less than an hour, and this number is sufficient to give very good values for both time and latitude.

An interesting feature of the astrolabe is that, unlike other instruments, the results obtained, if the prism be well constructed and by employing reasonable care, are almost entirely independent of errors due to maladjustment. The telescope should be perfectly horizontal; so also should the prism edges; and the rear face of the prism should be vertical. If, however, the prism edges, for example, are not horizontal, the skilled observer will recognize this fact when he perceives the motion of the star in the field of view and a slight touch of a screw eliminates the inconvenience; indeed, this adjustment is generally effected on every star.

The one important adjustment—and even that is not absolutely essential—is the perpendicularity of the rear face of the prism to the axis of the telescope, which is easily effected by aid of a simple auxiliary device. If the adjustments are not perfect, the only error involved is in the observed altitude which, instead of being 60°, may be some larger or smaller quantity; but if care is taken to make all observations in the same portion of the field, and in the same way, this quantity will be the same in all positions of the instrument. All stars will be observed at the same altitude, and the resulting latitude

*U. S. Naval Observatory, Washington, D. C.

and local time will be unaffected. With the newer type of prismatic astrolabe, permitting temporary field illumination, this condition is easily fulfilled.

There are no instrumental constants to be determined, and consequently there are no systematic errors introduced by such constants. There are no circle measures, with the danger of reading and recording them incorrectly. There are no errors of nadir, pointing, thread inclination, pivots, etc., such as affect observations with other instruments. In fact, nearly all constant errors, affecting all observations alike, are eliminated. There is danger of systematic error introduced by the personal equation in noting the times of observation, but almost all other errors are of the accidental class, and may be eliminated by increasing sufficiently the number of observed stars.

The manipulation of the instrument is simple, rapid and easy. The French employ one or two assistants, but a single observer can work just as easily and quickly without aid. Guided by a previously prepared list of stars containing approximate times and azimuths, the observer first sets the telescope in azimuth, then seating himself at the eye end, watches the star and its reflected image enter the field of view from opposite directions. He touches a screw, perhaps, to cause the images to change slightly their relative positions, or to bring their vertical line nearer the center of the field. As the images draw closer in their approach toward each other, he concentrates his attention and at the moment of coincidence makes a record of the time, either by the eye and ear method, or by the chronograph and key. In this record is comprised the whole observation.

The computations both preliminary to and succeeding the observations are long and tedious. An hour's observing list requires many hours of preparation and subsequent computation. The labor of preparing the observing list may be considerably shortened by tables and other aids; and the final computations, too, may be made more easy by tables and graphic processes. The fact, nevertheless, remains that the computations are time consuming. In view of the high precision attainable, this objection should carry but little weight, particularly when it is remembered that the computations may be made at one's leisure, long after the observations have been completed.

The instrument is comparatively inexpensive, it is light and portable, and requires no previously established stable foundation, but may be set up in a few minutes. These considerations should recommend it particularly to geographers, explorers, surveyors and other travelers who seek accuracy, yet do not wish to encumber themselves with the comparatively heavy portable transit and accompanying chronograph. For the very finest kinds of longitude work, however, owing to the personal equation, the astrolabe should be looked upon with suspicion. Yet it should be remarked that it has been used side by side with portable astonomic transits of the best known types, and the results obtained by the two different kinds of instrument have been wonderfully close.

The prismatic astrolabe has been employed by the French on boundary and other survey work in their colonies, in the measurement of a meridian arc in Ecuador, and more recently in important wireless longitude determinations. It was used last spring in the preliminary operations attending the determination of the difference of longitude between Washington and Paris.

The astrolabe may be employed for absolute longitudes by observing equal altitudes of stars and of the moon. It can advantageously replace the portable transit in much of the longitude work now carried on in this country, and would result in considerable saving. Among other applications, it may be employed at fixed observatories to determine star positions. Our astronomers and engineers should give it a trial.

For an exhaustive discussion, the reader is recommended to A. Claude et L. Duencourt, "Description et Usage de L' Astrolabe à Prisme."

The Twelfth St. Viaduct Accident, St. Louis

Supplementing the account in our last issue (p. 706) of the accident at the Twelfth Street Viaduct in St. Louis, we reproduce herewith a general view of the span affected by the wreck. The span crosses two tracks of the Missouri Pacific Ry., and is 54 ft. long. It consists of reinforced-concrete main beams and transverse slab (the slab reinforcing rods show in the view). Each main beam was supported by 24-in. I-beams resting on pairs of 8x8-in. wooden posts. It is believed that failure of one or more of these posts, possibly from lack of bracing, caused the collapse. Three main beams went down. At the time the photograph was taken, the wreckage had practically all been cleared away. Practically no delay will result. This was the last span of the viaduct to be concreted.

PARTIAL WRECK OF SPAN 16 OF TWELFTH STREET VIADUCT, ST. LOUIS, MO.

(This span crosses Missouri Pacific tracks. Three main beams or stringers of 54-ft. span went down, shortly after being poured, due to failure of the posts supporting the steel centering beams.)

Notes from Engineering Schools

HARVARD UNIVERSITY—The half course in administration of municipal sanitation given last year has been expanded to a full course to be given three times a week throughout the coming year. The course will not be confined to sanitation but will include city administration, vital statistics, city planning, housing, fire protection, public lighting and paving. Special outside lecturers will have charge of six exercises each—in order to give adequate treatment of their subjects. The topics are essentially of engineering nature but are to be presented for those who desire to fit themselves for municipal executive and legislative effort.

MICHIGAN COLLEGE OF MINES—This institution has opened its doors to the practical mining man. Announcement has been made of the introduction this year of a series of special short courses in mining, metallurgy, mapping, drawing, concrete construction and like subjects that will be open to ambitious workingmen. This step has been under consideration for many years and is now introduced as a permanent extension of the college work, designed to broaden its usefulness.

The admission requirements for the new courses are simple. It is required first that a man be able to read and write the English language to a fair degree of proficiency. The second demand is that a man be of good character and have had experience in the mine, mill, smelter, shop, etc.

The courses will run from five to twelve weeks, probably coincident with the regular college work. The same teachers and equipment will be used in this work as in the regular college courses. Every course will be given under the head of the department to which the subject belongs. There has been no attempt to place definite limits on the number of courses or the ground to be covered by them. They are to be arranged to suit the demand. It is intended also to pay particular attention to men who come for special work—whether with previous technical training or not.

NEWS NOTES

Recent Floods in Polk County, Iowa, are reported to have carried out 50 culverts and 22 bridges on the county highways.

An Explosion of Natural Gas in a Building Basement practically destroyed a five-story building at Akron, Ohio, Oct. 1. Four persons were seriously injured.

A Mine Explosion at the Mulga mines of the Woodward Iron Co., near Ensley, Ala., on Oct. 5 is reported to have killed 16 men and injured 12 others. The explosion is described as a gas explosion. At the same mines on Apr. 20, 1910 some 40 men were killed in a similar disaster.

An Explosion in a Fireworks Factory at Jersey City, N. J., Oct. 3, caused the death of four men and injuries to many. The explosion occurred in the drying room of the plant of the Detwiller & Street Co. The superintendent of the plant has been placed under arrest on the charge of manslaughter.

A Boiler Explosion at the power house of the Spring Cañon Coal Co., Storrs, Utah, caused the death of two men and injuries to five more on Sept. 28. The boiler is reported to have been the marine high-pressure type and is said to have been recently repaired.

An Explosion in the Fireworks Factory of the Pain Fireworks Display Co. of America, Chicago, Ill., on Sept. 30, caused the death of the President of the company, H. B. Thearle, and three of his office employees. The explosion took place in the steel and concrete vault in the office building. The explosion is supposed to have been caused by a spark from the electric wiring on which an electrician was at work at the time of the explosion.

A 36-In. Water Main Was Broken by a dredge excavating for the foundations of the Wellington Bridge over the Mystic River, in the suburbs of Boston, Mass., on Oct. 3. Reports state that the break was caused by driving a spud through the submerged main. A large quantity of water was lost before the gates could be closed, which required nearly an hour. Soon after the gates were closed the pressure in other parallel mains increased and nearly normal conditions in the suburbs of Charlestown, East Boston, Cambridge, Chelsea and other towns were restored. The main is a part of the Metropolitan Water Board's distribution system.

The New Boylston St. Subway, Boston, Mass., was opened to the public Oct. 3. The new subway cost approximately $4,500,000, and will give rapid transit service to Brookline, Brighton and Allston. Construction was begun in March, 1912.

Statistics of Foreign Trade of the United States for August show an increase in imports of $8,000,000 over the same month in 1914, while the exports decreased $77,000,000. The falling off in exports was entirely in manufactured goods and raw materials for manufacturers' use. The exports of foods remained substantially the same. Much more radical changes will doubtless be shown by the returns for September.

Installation of a 50 Million-Gal. Chlorinating Plant was recently made in 28 minutes at the Watts Pond pumping station, Brooklyn, N. Y. It was desired to disinfect the water-supply from this station without delay, and a telephone order was placed with Wallace & Tiernan, of New York, makers of treating apparatus for use with liquid chlorine. Two men were sent out with a set mounted ready for use on a panel board and calibrated so that it had only to be fastened to the station wall and connected to the chlorine tank and water-supply lines.

Improvements on the Chicago, Milwaukee & St. Paul R.R.—"During the year 43 steel bridges, aggregating 4009 ft. in length and 6 masonry bridges, aggregating 676 ft. in length, were built—replacing 3430 ft. of wooden bridges, 1013 ft. of iron bridges and 242 ft. of embankment; and 13,568 ft. of wooden culverts were replaced with iron and concrete pipe. About 3.9 miles of pile bridges were filled with earth, 90 bridges having been completely filled and 70 reduced in length by filling."—From the company's annual report for the year ending June 30, 1914.

Grade Crossing Elimination on the Chicago, Milwaukee & St. Paul Ry. system is summarized as follows in the annual report of the company. In Minneapolis 37 grade crossings are being removed and the work is about 35% completed. In Chicago along the Bloomingdale Road for a distance of 2.4 miles 35 grade crossings are being removed. On the Evanston division work was begun last February on the elimination of 36 grade crossings, a distance of 4.4 miles. In Milwaukee, 14 grade crossings are being removed. The work will require about two years.

Impulse Wheel for 5412-Ft. Head—Among the exhibits of the firm of Piccard, Piccet & Co., Geneva, Switzerland, at the Swiss National Exposition being held at Berne, Switzerland, is an impulse wheel built for the Fully high head plant of the Société d'Electrochimie, a French company. This is a horizontal shaft wheel which will develop 3000 hp. at 500 r.p.m. Its wheel diameter is 11½ ft. and the jet diameter is 1½ in. The Fully plant (as noted in "Engineering News," May 8, 1913, p. 986), will be the highest head water power plant in the world by a considerable margin. No machine for such severe conditions has been built prior to this one.

The Organization of Fraudulent Engineering and Drafting Companies, which offer to give positions to employees on condition that they invest in the concern, has been given another check by the arrest in Chicago of a man who has been making this a business. We reported the operations of Theodore Rodmann, in Cleveland and Chicago, some months ago, and the Chicago "Tribune" of Sept. 22 reported that he had been arrested by federal officers on charges of defrauding a man by use of the mails. The report states that the man was induced to invest on condition that he should become sales manager of a concern at $200 a month for two years, but was discharged after one month.

A Street Extension by Subway at Open Cut through a public park is proposed at Chicago. At present Division St., a main thoroughfare on the west side, is interrupted by Humboldt Park, and the street cars stop at the park. The

West Side Park Commission objects to having the car tracks extended through the park, and in order to meet this objection the Northwest Side Commercial Association has had plans prepared for carrying the tracks either in a covered subway or an open cut, with inclined approaches. These plans, prepared by Wm. W. Marr, have been submitted to the park commission, and the estimated cost is $65,000 for the open cut and $110,000 for the subway.

Elimination of Traffic Congestion at the foot of Market St., San Francisco, is being considered by the city in a plan which contemplates the acquisition of six parcels of land from two city blocks to create a new street two blocks long, 91½ ft wide, parallel to and 137½ ft. south of Market St. The present ferry-bound cars on Market St. would be rerouted through this new avenue of approach to the Embarcadero to prevent the procession of cars there in opposite directions due to the present ferry-loop tracks. The terminals of the Mission, Howard and Fulsom St. lines could be shortened 100 ft. Two foot bridges of structural steel and reinforced concrete would be built, running from the second story of the ferry building over the Embarcadero in the general line of and on either side of Market St., with entrances and exits to give best access to various street-railway lines, sidewalks and ferries. The estimated cost is placed at $380,000 for land, $49,000 for street-railway changes, $59,000 for foot bridges, $15,000 for changes to Ferry Building.

The Railways of Great Britain were taken over for operation by the British Government at the outbreak of the war and are operated as a single system under control of a committee made up of the General Managers of all the principal railway companies. The operation of the railways proceeds as usual, except that the military requirements of the government are paramount to all other traffic considerations. The compensation to be paid to the companies owning the roads for their use will be the net receipts from operations increased by the amount by which the net receipts during the period of government operation may fall short of the net receipts during the corresponding period in 1913. It is provided, however, that where the net receipts of any railway were less in the first half of 1914 than in the corresponding half of 1913 the basis on which compensation is to be computed shall be decreased in like proportion. Under this arrangement the government makes no special payment for transportation of troops or any other service performed for the government, this being paid for under the arrangmeent above noted.

Grade Crossing Elimination in Paterson, N. J. has been investigated by the City Engineer, H. J. Harder. He estimates, in a report to the Finance Commission of the City, on Oct. 1, that to depress the tracks of the New York, Susquehanna & Western would cost $2,772,000, while to elevate the tracks of the Erie would cost $2,587,000. Land damages have not been included in either estimate. The work of depressing the Susquehanna tracks may be divided into four independent sections, any of which may be completed without the others and without the duplication of any work when the other sections are constructed. The average estimated cost is $139 per lin.ft. for the Susquehanna against $142 for the Erie.

The bridges over the streets would be of the through plate girder type with waterproof trough floors. Those carrying the streets over the railroad would be of a similar type, except that where street intersections come on the railroad right-of-way the bridges would probably consist of concrete arches thrown between heavy I-beams extending from one abutment to the other. The Susquehanna right-of-way in most places is wider than that of the Erie, and it will be possible to allow the cuts and fills to run out on natural slopes part of the way. Retaining walls will be required, however, along the greater part of the line. These will be of concrete backed by dry rubble to carry off the drainage.

Street grades on approaches to crossings have in nearly all cases been kept below 4%, in only two or three places reaching 5% and in one instance 6%.

PERSONALS

Mr. Frank M. Williams, M. Am. Soc. C. E., former State Engineer of New York, has been nominated for that office by the Republican Party at the recent primaries.

Mr. Jesse C. Bader has been appointed Manager of the Western Sales Branch of the McMyler Interstate Co., of Cleveland, Ohio, with headquarters at 1503 Fisher Bldg., Chicago, Ill.

Mr. Leslie Warren Goddard, M. Am. Soc. C. E., Principal Assistant Engineer, U. S. Engineer Office, Grand Rapids, Mich. was married Sept. 26 to Miss Mina Etta Bordine, of Saline, Mich.

Mr. Patrick Kierman, for 30 years Superintendent of the Fall River, Mass., water-works, has resigned. He has been a member of the New England Water Works Association for 28 years.

Mr. John A. Bensel, Past-President, Am. Soc. C. E., State Engineer of New York, has been renominated as a candidate for the same office by the Democratic Party at the recent primaries.

Mr. F. J. McKee, who has been Acting Superintendent of Terminals of the Grand Trunk Ry. at Port Huron, Mich., has been promoted to be Superintendent, succeeding Mr. J. F. Jones, resigned on account of ill health.

Mr. Alfred E. Kornfeld, who relinquished his connection with "Engineering News" in 1912 after 18 years' service, has again become identified with it and as a member of its business staff, with headquarters in New York City.

Mr. George P. Johnson has resigned as General Manager of the Chesapeake & Ohio Ry., Richmond, Va., and for the present no successor will be appointed. Mr. Johnson was formerly Receiver for the Detroit, Toledo & Ironton Ry.

Mr. R. F. Peters, M. Am. Soc. M. E., recently Mechanical Engineer of the San Antonio & Aransas Pass Ry., has been appointed Senior Mechanical Engineer, Division of Valuation, Interstate Commerce Commission, with headquarters at Kansas City, Mo.

Mr. T. B. Van Dorn, Vice-President and Engineer of the Van Dorn Iron Works of Cleveland, Ohio, has been elected President, to fill the vacancy caused by the death of his father, the late J. H. Van Dorn, who was the head of the company for 35 years.

Mr. C. M. Cott, formerly with the engineering staff of the McClintic-Marshall Co., of Pittsburgh, Penn., and recently Chief Engineer of the Champion Iron Co., Cleveland, Ohio, has been appointed Manager of the new Cleveland office of the Trussed Concrete Steel Co., of Youngstown, Ohio.

Mr. E. M. Mohrman, recently Superintendent of Construction and Division Engineer of the Twin Falls Land & Water Co., Twin Falls, Idaho, has accepted a position with the Trussed Concrete Steel Co., of Youngstown, Ohio, with headquarters at the newly established offices of the company in Cleveland, Ohio.

Edward J. Kunze, M. Am. Soc. M. E., who for the past four years has been Assistant Professor of Mechanical Engineering in charge of machine design and construction at the Michigan Agricultural College, has been appointed Professor of Mechanical Engineering in charge of the department of mechanical engineering at the Oklahoma Agricultural and Mechanical College.

Mr. T. Coleman du Pont is reported to have abandoned his plans to build a $2,000,000 highway for the state of Delaware because of the opposition which developed against the acquisition of land for right-of-way. The engineering force gathered to build the road, the organization of which was described in "Engineering News" of Jan. 25, 1912, has been disbanded. Mr. du Pont has already spent about $100,000 on the project.

Mr. Thomas D. Pierce, Assoc. M. Am. Soc. C. E., recently Assistant Engineer, Valuation Department, Toledo & Ohio Central Ry., has been appointed Appraisal Engineer of the Public Utilities Commission of Ohio. The appointment was received through a civil service examination, in which Mr. Pierce ranked high. He is a graduate of Case School of Applied Science, Cleveland, Ohio, and has had about ten years experience in railway location and construction, and in appraisal work.

Messrs. J. C. McGormley and J. J. King, formerly of Toledo, Ohio, have formed the McGormley-King Co., with offices at 641 Engineers' Bldg., Cleveland, Ohio. Mr. McGormley was Secretary and Treasurer of the De Ware-McGormley Co., Industrial Engineers of Toledo; and Mr. King was employed in a similar capacity with the Henehan-King Co., General Contractors, also of Toledo. The new firm will specialize in industrial engineering, particularly the design and construction of factory buildings.

Messrs. John Garretson Eadie, Mortimer Freund and James Kenneth Campbell announce that they have established the firm of Eadie, Freund & Campbell, Consulting Engineers, 7 W. 45th St., New York City. The new firm will specialize in the design and supervision of installations for the heating, ventilation, lighting, plumbing, water supply, refrigeration and automatic sprinkling of all classes of build-

ings, and also of plants for the production and application of motive power in industrial establishments.

The New York State College of Forestry at Syracuse, N. Y., has added to its faculty the following: Prof. J. Fred Baker, formerly in charge of the Department of Forestry at the Michigan Agricultural College, is to take charge of experimental work in forestry; Mr. Shirley W. Allen, Deputy Forest Supervisor, U. S. Forest Service, a graduate in forestry of the Iowa State College, will aid in extension work in forestry; Dr. C. C. Adams, recently at the University of Illinois, has been appointed Forest Zoologist; Dr. L. H. Pennington, of the University of Michigan, has been appointed Forest Pathologist, and Dr. H. P. Brown, of Cornell University, has been appointed Forest Botanist.

Mr. Paul P. Whitham, Assoc. M. Am. Soc. C. E., has resigned as Chief Engineer of the Port of Seattle, to engage in private practice with offices in the New York Bldg., Seattle, Wash. The Seattle harbor improvements which have cost upward of $6,000,000, are now practically completed. Mr. Whitham will be associated with Mr. George W. Evans, M. Am. Inst. M. E., Chief of Coal Surveys, U. S. Geological Survey. Mr. Whitham, as Chief Engineer of the Seattle Port Commission, had charge of the design and construction of the Stacy St. terminals in the East Waterway, Central Pier No. 1, and warehouse, the Smith Cove Pier, Salmon Bay terminals and the East Waterway turning basin and improvements including a very large grain elevator, and cold-storage warehouses. Mr. Whitham has previously been Chief Engineer of the Seattle Public Utilities Department, and also Engineer of the Astoria Port Commission.

Dr. Allan J. McLaughlin, Surgeon, United States Public Health Service, has been appointed Commissioner of Health of Massachusetts, at a salary $7500 per annum for a term of five years. The position is a new one, created by a law which went into effect Aug. 6, 1914, abolishing the old State Board of Health, whose executive officer was the Secretary, and establishing a State Department of Health, of which the newly appointed Commissioner is the Chief. The law creating the new department was reprinted in our issue of July 16, 1914, and commented upon in the editorial columns of the following issue, July 23. Dr. McLaughlin was born in London, Ont., June 26, 1872. He graduated at the London Collegiate Institute in 1887, and at the Detroit College of Medicine in 1896. In 1900 he was appointed Acting Assistant Surgeon, U. S. Public Health and Marine Hospital, and was promoted through successive grades to be Surgeon in 1912. He served both in this country and abroad and from 1908 to 1909 was Acting Director of Health for the Philippine Islands. In 1911 and 1912 he was in charge of the federal investigation of sewage pollution of the Great Lakes and the Missouri River, and since 1913 has been Chief Sanitary Expert and Director of Fieldwork for the International Joint Commission.

OBITUARY

James Lyman, for many years a prominent Chicago public works contractor, died at his home in that city, Sept. 27. He had been a resident of Chicago since 1852.

Marshall E. Johns, former General Superintendent of New York, Susquehanna & Western R.R., died Oct. 2, at his home in Paterson, N. J., aged 54 years. He was born in Washington, D. C., in 1860 and began his railway experience in 1876 as a brakeman on the Montclair & Greenwood Lake R.R.

Robert McCulloch, President and General Manager of the United Railways Co., of St. Louis, Mo., died Sept. 28, at the age of 73. He was born in Missouri but the family soon afterward moved to Virginia, where he was graduated from the Virginia Military Institute. He served in the Confederate Army during the Civil War and rose to the rank of Captain. After the war he entered the street railway business, and was connected with some of the earlier lines in St. Louis. He was General Manager of the Chicago City Ry. Co. from 1900 to 1904, when he went to the United Railways Co. of St. Louis.

Thomas P. Brown, Superintendent at New Orleans, La., in the Eighth Lighthouse District, U. S. Bureau of Lighthouses, died Sept. 27 at his old home in Mobile, Ala. He was born in Mobile 49 years ago and graduated from the University of Alabama in 1885. He received the degree of Civil Engineer there in 1894. For the last 20 years he had been in the U. S. Government service at Mobile and New Orleans. During the early part of this time he was Inspector and Assistant Engineer on fortifications and river and harbor work under the Corps of Engineers. Later he became connected with the Lighthouse Service, and during this period he had charge of construction of several large lighthouses on the Gulf coast, among them the Sabine Bank Light, which is a caisson structure some 15 miles from shore, presenting many difficulties in construction.

A. Considère, Inspector General, retired, of the Ponts et Chaussees of France, has just died at the age of 72. M. Considère was probably better known in America than any other continental European engineer, particularly in the field of testing materials and of concrete. A large part of his professional career was spent at Quimper, where, while serving as an engineer in his corps, he devoted so much attention to the testing of materials. He was one of the earliest of modern engineers to investigate thoroughly the properties of concrete, and particularly of reinforced concrete. In 1898 Considère published the results of his researches on mortars, concretes and reinforcement—a book which immediately took its place as the foremost exposition of the subject. It was as a result of his investigation published at this time that he announced the well known theory that the conjunction of steel and concrete gave to each of the two materials elastic properties which separately they did not possess. This theory was accepted by the scientific world for a number of years, but was later disproved by the famous Turneaure tests at the University of Wisconsin. Considère's name is also connected with another radical development in reinforced concrete, namely, the hooped column, which he devised some years ago. He was a prominent member of the International Association for Testing Materials and was prominently spoken of for the presidency of the international commission on reinforced concrete established in 1907. Since his retirement, some years ago, M. Considère has been at the head of a bureau for testing materials which he established in Paris.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20-22. Convention at Los Angeles, Calif. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Oct. 20-23. Annual convention at New Orleans. Secy., James McFall, Roanoke, Va.

AMERICAN GAS INSTITUTE.
Oct. 20-23. Annual meeting in New York. Secy., George G. Ramdell, 29 W. 39th St., New York City.

NORTHWESTERN ROAD CONGRESS.
Oct. 28-31. Congress at Milwaukee, Wis. Headquarters, 71 Sentinel Bldg., Milwaukee, Wis.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

INDUSTRIAL WELFARE AND EFFICIENCY CONFERENCE.
Nov. 16-20. Conference at Harrisburg, Penn. Secy., R. M. Pennock, Harrisburg, Penn.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
Nov. 19-20. Annual meeting at Columbus, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Nov. 30—Dec. 1. Annual meeting at New York. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 2-4. Convention at Washington, D. C. Secy., D. Knickerbacker Boyd, The Octagon, Washington, D. C.

AMERICAN MINING CONGRESS.
Dec. 7-11. Annual meeting at Phœnix, Ariz. Secy., J. F. Callbreath, Denver, Col.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 9-12. Convention at Richmond, Va. Secy., C. A. Prosser, 140 W. 42d St., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 10-11. Annual meeting at New York City. Secy., D. H. Cox, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Madison, Wis. Secy., F. M. White, Madison, Wis.